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SOME ASPECTS OF POLITICAL GEOGRAPHY.*

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When first honoured by an invitation to address a Cambridge University audience on a geographical subject, I accepted that invitation without due consideration. For it now appears to me to be sheer presumption to imagine that any words of mine can usefully supplement the ample measure of theoretical and practical instruction which the University offers to geographical students. Time was (and not so very long ago either) when the whole wide area of scientific knowledge embraced in the broad field of geography was narrowed to a ridiculous little educational streamlet which babbled of place-names and country products. Scanty as was the educational value of geographical teaching fifty years ago, it was almost equalled in its feebleness by the practical knowledge of the subject which included the all-important matter of map-making. True we had our geodetic scientists, and much profound thought and practical energy had already been devoted to solving the riddle of the Earth's form and dimensions, such as laid the foundation for an after extension of valuable bases for surface measurement which would certainly sustain the building up of maps. But the science of geodesy was still too much in the academic stage, and our systems of map-making were framed on old-world principles, immensely costly and profoundly slow, which were applied to Great Britain with more or less useful effect but which left Greater Britain untouched and uncared for. I think we may fairly claim that it was the adoption of continental methods in India, and the rapid extension and adaptation of those methods in that vast and varied continent which first opened the eyes of business administrators to the enormous advantages, commercial,

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political, or military, which were to be gained by comprehensive and sweeping surveys.

Nearly forty years ago, I had the honour of introducing to a select but limited audience at the United Service Institution the simple survey instrument called the plane-table. There was at that time not one in England. The clumsy specimen which was prepared for the purpose of illustration of that lecture served as a sort of model for instructors subsequently, and I can hardly express the difference between the practice of geography in the necessary branch of map-making in those days and in these, better than by pointing out that in those days the plane-table was an unknown accessory to the equipment of the geographical surveyor, whilst in these its use is taught in every survey school.

But it was not the development of map-making alone (although I regard that as the ultimate object of all geodetic science) which led to the better appreciation of the absolute necessity for scientific geographical education in the very widest sense of the term. It was the practical consideration that we were being left very far behind in the field, not so much of research (for there we have always held our own), but of that practical knowledge which profoundly affected our position as a commercial nation, our prospects in the military field, or our political dealings with other countries when questions arose of the partition of spheres of interest, that forced the conservative hand of our educational administration and led to the formation of geographical schools throughout the breadth of the country. In short, it began to be quite clear that geography was a science which had to be reckoned with, and which it paid pre-eminently to study. But so wide is the field which that science embraces, so intricate are its relations with almost every other existing natural science, which either has its roots in land formations and a growth dependent on climatic influence, or else is in itself the bed-rock of such formations, that a whole world of separate and distinct branches of geographical study have arisen in connection with them. But we need not waste time now in the discussion of what geography covers. I rather share the view expressed by Prof. Davis, who said that he was a geologist rather than a geographer, for, after all, "geography is only the geology of to-day;" and he added, "If this seems to subordinate geography too much to geology, it may be appropriate to state that I regard all geology as only the summation of a vast series of geographies, the chief difference between the present and the earlier geographies being that the one lies directly before us and is therefore open to immediate observation, while all the others are known only through very imperfect records, and are therefore largely matters of inference. A geologist who is making a study of a certain period would be delighted if he could draw maps of the lands and waters of that time, and pictures of the scenery and the inhabitants just as a geographer draws for to-day."

This, however, lands us in the speculative side of the subject, and it is neither the speculative nor the strictly scientific side to which I desire to call your attention now, but to matters eminently practical, in which my own individual and original experience may perhaps count for something in a paper which I fear may have little else to recommend it. As my experiences have been essentially those of a map-maker and boundary demarcator, it is to the field of problems connected with this branch of geography that I would conduct you, and even then I propose to limit myself to a few suggestions which seem to be specially suited to the present occasion and to the probable opportunities which the future may present to you. You all know that the basis of all map-making is a geodetic framework. On this all else must ultimately hang, and the necessity for it is the greater, the larger the area of the world's surface that lies open to the topographer. There should be no mistake about this. Whatever may be the outcome of geodetic measurements (conducted and perfected with all the scientific care of the best observers in the world), as regards scientific theories of the world's shape and the corrections that thereby may be introduced into those data from which our computations of latitude, longitude, and azimuth are deduced, there is this solid practical effect of it—that it furnishes the anatomy or framework of the whole world's map-construction; and as the years roll on, and here and there a continental area is added to the map-geography of the Earth, there will be no fitting together of the patchwork puzzle—no unity or continuity of illustration—unless it is nailed down to a pre-existing geodetic framework. The Geodetic Conference, which has lately been held, and in which the leading geodetic surveyors of Britain and India have taken part, is therefore of world-wide significance. We may fairly trust that from it there will work out an accordant system universally adaptable, which will bind together the scientific efforts of all nations concerned in the future development and civilization of the dark places of the world.

In urging the importance of their world's work, our geodetic supporters should not claim too much. Perfect, absolute accuracy is not in accordance with the dispositions of nature. Finality is not attainable on this Earth, and we may hope to see a little less of the appearance of final and absolute determination of value, either in co-ordinate position or in altitude, which sometimes indicate a minute precision which is not really warranted by the results of observation or of computation. In the purely geodetic field it is still those unknown qualities dependent on the, as yet, unascertained figure of the Earth which introduce trouble and work mischief. In other fields dependent on a geodetic basis, but not ranking directly as geodesy, it is the unknown factors in the physical constitution of our atmosphere which are the most disturbing. The altitudes of high and unapproachable peaks, for instance, can never be said to be determined to within many feet of their probable, or

possible, value; and it is a mistake to enter them in our maps in other than round figures denoting this uncertainty. Nevertheless, when all is said, direct observation is our only means of ensuring relative accuracy. As in the case of altitudes not all the barometric observations that could be taken over weeks and months of careful daily record will give results which can compare in probable accuracy with the roughest form of direct observation by triangulation; so you may surely reckon that no substitute, no provisional method of Earth-measurement, can possibly take the place eventually of that geodetic backbone of all map anatomy which we may typify to-day by the great arc of direct triangulation which is being gradually measured through the length of Africa.

But all this initial process must necessarily be in the hands of scientists—and science moves slowly, if surely, and it is usually expensive. The world cannot sit idle and wait for this slow evolution of exact determinations on strict geodetic principles before demanding maps. And we have found now, by the experience of the last twenty or thirty years, that other provisional methods, methods which involve the use of a smaller class of instrument and rapid progress through a country, are quite sufficient to enable us to spread out our map-system on comparatively small scales of work over the vast areas that are of primary interest to the commercial, military, or political geographer, without the accumulation of any error that would invalidate the map. And this is the sort of work that you, gentlemen, in the capacity of travellers with a purpose, which purpose may be ethnological, archæological, geological, or, in fact, which may represent any branch of natural science which requires map illustration, can all readily learn to do. It is this sort of practical geography which we wanted in South Africa and did not possess. It is this which is wanting wherever a political discussion arises as to respective spheres of national interest, and which usually remains wanting. It is often by means of the early possession of geographical data of quite the most elementary type that the commercial pioneer succeeds in striking in effectively to the development of a fresh trade area, and, like the early bird, succeeds in securing the first fat worms.

I am not going to trouble you with details as to how this class of work can be best accomplished. Your most able and energetic staff of instructors can tell you that quite as well, if not better, than I can, although, maybe, I have had more rough practical experience. It is sufficient to me to be able to record with a certain note of thanksgiving that our geographical schools can now turn out fair topographers by the score, whether for military purposes or for civil, and that our geographical travellers take the field with an aptitude for recording what they see, and a set purpose of effecting some useful research, designed to give new knowledge to the world, which was practically unknown in the days of such heroes as Speke or Burton. It is in connection with one

special branch of this class of geographical map-making that I think I may usefully employ the short space of time at my disposal by recounting some of the difficulties which I have encountered as a boundary demarcator, and suggesting means for their avoidance in future.

This is an age of boundary making. It is an age of partitioning and dividing territory—a process which has by no means ended yet, and which may continue whilst the world endures. And the territories to be partitioned to which political boundaries have to be set, are mostly dark and remote, and have been hitherto guiltless of any map-illustration of sufficient accuracy to ensure confidence in demarcation. All sorts of countries, under all sorts of conditions of government, from the black barbarism of Central Africa to the hot-house civilization of South America, have been subject to the process, and of all of them may the same thing be said, *i.e.* that the process of boundary fixing has finally revolved itself into a strictly geographical problem. Indeed, it must always be so. A boundary is an artificial impress upon the surface of the land, as much as a road or a railway, and like the road or the railway, it must adapt itself to the topographical conditions of the country it traverses. If it does not, it is likely to be no boundary at all. Boundaries have been twisted out of every conceivable natural feature, with more or less success. Those that have been defined in abstract terms of meridians and parallels, or other abstract lines, for want of knowledge of existing natural features, have never proved satisfactory. The very first preliminary to a boundary settlement should be, where possible, a reasonably clear topographical illustration of the country concerned. But it is not always possible, and it may happen that the mere agreement between two countries upon an abstract definition may be all that is necessary for the time being. In that case, a store of future trouble may be laid up unless the agreement is carefully regarded as provisional only.

Here, then, we have the first great rock upon which boundary definitions usually split. It is want of geographical knowledge. If, indeed, it is compulsory ignorance, if there is no possibility of waiting till maps can be made and arbitrators are forced into the position of adopting the worst of all possible boundaries, *i.e.* those defined by straight lines (whether co-ordinate lines in latitude or longitude, or any other system of straight lines independent of natural features), a provisional or elastic agreement is essential to the probability of successful demarcation.

Some notable instances have occurred lately in connection with boundary settlements in Central and Southern Africa which strongly support this contention. In one case a meridian line was selected before even such preliminary investigations were concluded as might have determined a fairly accurate longitude and fixed a point on that meridian. The result was an international complication as soon as it was discovered that in the neighbourhood of the Ruwenzori mountains

a wide tract of valuable land had been erroneously assigned to England which subsequently had to be transferred to Belgium. In that case, I think I am right in stating that quite enough of the features of the country were known to decide whereabouts the dividing line should run, only, unfortunately, the meridian fixed upon did not happen to represent the line. There was no excuse for the mistake.

In another instance a definite meridian line was adopted which traversed a desert—the Kalahari desert—of South Africa. Now, a desert may be a very good boundary in itself, just as may be the highest altitudes of a great range of mountains where eternal snow-fields and the remoteness of a stern white wilderness is never disturbed by the foot of man. It is true that even in deserts, African or Asiatic, wild nomadic tribes may sometimes exist who can band themselves for mischief, and who can raid across into each other's territory; and to them it may be desirable to point to a landmark, either natural or artificial, and to say, "You may not pass that mark." Outward and visible evidence of the boundary is the only sign that they can understand. But how does a meridian line help the matter? It is not only not outward and visible, but it may be very, very hard to determine. In this particular case a comparatively lengthy geodetic series of triangles had to be carried south of the boundary into German territory, entailing months, if not years, of scientific labour in a most unwholesome climate, and costing a sum equivalent to the value of many thousands of square miles of useful geographical mapping, in order to determine with some approach to scientific exactitude where that meridian really lay. Then the most expensive and unnecessary process of demarcating a straight line through the midst of the wilderness commenced, and the final result (which cost lives as well as money) was no more useful than would have been attained if a lightly equipped plane-tabler had run a compass traverse survey across the country (always assuming that artificial demarcation was necessary at all), and fixed up a pile of stones or rocks here and there within sight of each other. Something might have been said for the value of the geodetic series for the extension of ultimate surveys, but it was run chiefly in German territory. Perhaps the most successful example of a right-line boundary in existence is that which parts Canada from the United States. It has the advantage of being chiefly based on a parallel of latitude, and a parallel is comparatively easy of accurate determination astronomically. It would not be difficult, but it is unnecessary, to point out certain weaknesses even in that demarcation.

Next to absolute blank ignorance of the geographical conditions which prevail in the theatre of boundary operations, perhaps the hardest and most dangerous rock in the arbitrator's course is an inaccurate or assumed geography on which to base his treaty. Not so very long ago two great republics in South America, each entrusted with enormous financial interests by Europe, were at loggerheads over a boundary

which had been defined by treaty in this way. In many respects it was a very remarkable instance of the unwisdom of trusting to Nature's topographical dispositions as being arranged on any definite and normal plan. Throughout the western regions of South America there runs the magnificent Cordillera of the Andes. Cloud-capped, majestic, and inaccessible, the serried ranks of parallel folds, which enclose innumerable Andine valleys, admit no rival in the field of great mountain systems nearer than the Himalayas. Right through the midst of this gigantic natural barrier, dominating the minor ridges and folds, spilling its glacial waters on either side to the Pacific or the Atlantic oceans, there runs through all the Northern sections of the Andes one great divide. Few and scattered are the narrow ways which lead across that majestic rampart, and the traveller who passes through the mists out from the cradle of a river system on one side into the mountain streamlets of the other has no difficulty in recognizing that he has crossed a great water-parting. Here there is one of the best and grandest of Nature's own boundaries. No artificial waymarks are required to assist her demarcation. Perchance on the passes a pillar or a pile of stones may be useful to signify to the wayfarer that he has crossed the line of partition, but for the most part the wild grandeur of those eternal heights is unspoiled by artificial devices. Nothing indeed could be better, and for thousands of miles the central water-parting of the Andes is a grand political and international boundary. The trouble came with the reclamation of Patagonia in the south from the barbarities of Indian occupation, and its partition between Chili and the Argentine Republic. It was known that the Andine Cordillera continued southward through the continent. What more natural than that treaty-makers on either side should assume that Nature's excellent arrangement for a central water-parting should continue. At the time of treaty-making it was perhaps impossible to make exhaustive examination of the geographical conditions. Anyhow, the intention of the treaty was clear enough. The boundary was to follow the main range of the Cordillera, which parted the waters of the Pacific from those of the Atlantic. It was, in short, to continue towards the south under the same excellent conditions that supported it farther north.

When geographical explorers took the field it was not long ere they discovered that the conditions of the treaty were irreconcilable. The Southern Andes break up into a system which still contains all the grandeur of snow-capped ranges seamed by magnificent glaciers, and presents to the Pacific a snow-crowned rampart of majestic forest-clad hills, with here and there at regular intervals the white pinnacle of a volcano dominating its walls. But it softens down towards the Argentine pampas and plains into a comparatively irregular formation of lower ridge and furrow flanked by broad terraces, scarlet and purple in autumn with all the glory of the Patagonian beech scrub, and infinitely varied

both in form and colour. This lesser Cordillera encloses valleys of great beauty, and is frequently intersected, traversed, indeed, by lakes of surpassing loveliness, the waters of which draw this way and that, taking their sources frequently from the flats and masetas of the Argentine plains and passing them right through the mountain system to an exit in the Pacific. This to the treaty-makers was unexpected and vexatious, and experts on either side were deputed to prove that the boundary could but take one course, which course (according to the side from which it was argued) was either the main range of the Cordillera, *i.e.* that which was highest and most dominating; or else the main water-parting of the continent, which sometimes followed a range and sometimes was exceedingly hard to find amidst marshy flats. These experts respectively proved their case in a series of really splendid volumes, which I still regard with admiration, but which left international difference of opinion exactly the same at the end of these literary efforts as at the beginning. War seemed the only possible outcome of the dispute. Millions, many millions, were spent in ships and armament; and just that most natural assumption of a geographical conformation which did not exist seemed likely to set back the tide of splendid progress of which both Republics could boast, and to wreck them on the shores of a long, bloody, and probably indecisive war. Fortunately, stern good sense prevailed in the end, and British arbitration, crowned by our King's award, was accepted with deep gratitude by some, and, I am inclined to think, with relief by all.

Another instance of the probably fatal result of assuming a geographical status on insufficient evidence may be quoted nearer home. Some of you may perhaps be able to cast back your memories to the time of a certain Liberal Government, under Mr. Gladstone's leading, which was exceedingly anxious to bring the tension of doubt and suspicion which surrounded Russia's proceedings in Asia to an end. This was to be achieved by setting a boundary between Russia and Afghanistan, and thus defining for as nearly "ever" as anything in this indecisive world can be, the limit of her progression southwards. Then followed the meeting between the high diplomatic dignitaries on either side and the definition of where that boundary was to run. Now I may be permitted to say at once that there have been far worse definitions perpetrated in later years than that one; but it happened, as it so often happens, that the geographical information on which it was based was vague and of an ancient date. It need not have been so, but it was. I have recorded my opinion often enough to make it unnecessary to repeat it, that of all natural boundaries the water-parting or divide between river systems is the soundest and best. But this, of course, presupposes that such a natural feature can be found for the boundary near the position which other and greater interests demand. Failing a water-parting, a river may be exceedingly useful, especially if

it is comparatively narrow and confined within rocky (and therefore unchangeable) banks. But a broad river in an open plain may be a veritable pitfall for the arbitrator. It may have a dozen channels, of which it is difficult to determine the main one. It may shift its course and wander irresponsibly in loops and curves in unexpected directions. It may throw up islands, as do the Indus and the Godavari, and the right of ownership may lead to an inextricable tangle. But, on the whole, the river Oxus, which is fairly well confined in its mountain channel from Lake Victoria to the plains, and sweeps with a broad expanse of silted flood across the flats, difficult to cross, as a rule, but with historic and much-used fords and ferries, may be accepted as a fine example of an indisputable line of separation between two great countries. The mischief of the Russo-Afghan boundary treaty came in with the mention of a particular post or village on the Oxus banks on which the boundary of the southern plains from the Hari Rud was to be directed. There was no such post. It had gone. Swept into the river by an unexpected change of course, it had been washed out of existence. But it took long to determine this fact. There had been long delay already in the field before the Russian Commission appeared. The historic incident of the Panjdeh action had passed. Herat had been placed in a state of defence, and it was clear that it would not take much to wreck the object of the commission altogether. Indeed, it was perilously near to shipwreck. The worst that happened, however, was delay in this case (and, of course, expense); but delay in the field of Afghanistan, with an uncertain and gout-ridden Amir dominating the political situation locally, was not diplomatic, to say the least of it. It was exceedingly dangerous, and we were well out of it.

Another shoal in the intricate sea of arbitration (even when that arbitration is based on ascertained topography) is the misapplication of a boundary to some impossible feature. This, indeed, is not very usual, but it is very fatal to rapid and satisfactory progress. Let me give you an instance. We will turn to one of the loveliest valleys in Afghanistan, the valley towards the head of which lies the historic fortress of Chitral. The valley is narrow, the broad flats which border the feet of the Kashmund mountains to the south where the river winds in loops of azure through emerald fields, have given place to closely terraced hillsides with villages clinging limpet-like to the rocky spurs, and the river rushing as a noisy torrent in an eroded water-way of cliff-faced gorge. Here was the question of setting a limit to Afghan interference with tribes which recognized (more or less) British political supervision, and which were, when I left India ten years ago, termed "independent." It was, in short, the Afghan boundary on the Indian side of it that was under demarcation, and the commission party was safeguarded by an Afghan escort that was technically true to its trust, but at the same time was undoubtedly secretly interested in the siege of Chitral, not so

very far from the scene of boundary operations. The boundary agreement had been concluded with the Amir at Kabul, and that wily monarch Abdurrahmon was undoubtedly well aware of the value of map evidence. The river could not, under the principles which governed the agreement, serve as a boundary. It would indeed have found a most awkward division between interests on either side of it which were often indivisible. Back from the left bank of the river, but with flat terraces carved out of the rugged spurs at its foot, stood a well-defined range, one of the many great offshoots of the Hindu Kush, with its water-parting line removed some 6 miles or so from the river and parallel to it. The boundary had been defined as running parallel to the river on the side of that range, at an even distance of 4 miles, and thus it fell on the spurs of the range (say about halfway between the summit of the range and its foot) passing from spur to spur, cutting across mountain torrents, a continuous line of ascent and descent over some of the wildest, ruggedest, and most inaccessible mountain-side country that the Indian frontier presents. Demarcation was an utter impossibility. There was no measuring the 4-mile limit with any approach to accuracy, nor could, or would, any tribesman of the wild Pathan frontier pretend to recognize such a line without an infinity of artificial boundary-marks. Fortunately, it was possible to suggest an alternative without great loss of time, and as that alternative was the crest of the range (an unmistakable feature in that particular range) instead of halfway down its rugged side, and as the shifting would concede territory to the Afghan, there was no great difficulty in effecting an alteration in the text of the agreement. Here again the hazard of the business was delay. Delay and inactivity in regions such as Afghanistan, or the Indian hinterland, spells idle hands and almost immediate mischief. The 4-mile limit might not necessarily lead to an impossible line for demarcation. In this case it should have been obvious that it must do so.

A word or two about demarcation as apart from definition. It is the crux of all boundary-making. Any one can define a paper boundary. It is the demarcator who has to do the spade work, to determine the sites for pillars and artificial boundary-marks, and to fit the line to the conformation of the land. And it is in this process that disputes are apt to arise. It is then that the value of a few acres more or less becomes apparent, and may lead to serious disagreement. Important features, such as wells and springs influencing the agricultural prospects of large areas of country, are apt to be discovered in unexpected positions, and a thousand points of local importance are found which never were taken into account by the arbitrators, whose definition leaves their destination uncertain.

It is, however, seldom that boundaries have to be determined in highly developed countries where the most exact determinations of position and the most accurate surveys are necessary. It is usually on

a much larger and more comprehensive scale of interests that the determination has to be made, and in late years, at any rate, it is not the division of counties, but that of countries, which has had to be negotiated. Now, nothing perhaps so hampers and delays the progress of an important demarcation as the erection of artificial boundary-marks. They are almost invariably necessary in one part or another of a long boundary, but they are frequently multiplied to a most unnecessary extent and placed in positions where they are absolutely useless. A very well-defined water-parting should require no artificial assistance to add grace to Nature's provision of a boundary. A river, again, is obviously its own best demarcation; a comparatively wide space of desert may be quite definite enough, and the open sea sets its own limit with apparently little room left for argument. And yet, in all these geographical conditions, and many others which I might enumerate, there is almost invariably some point of exception which requires most careful investigation on the part of the demarcator. The well-defined water-parting has passes across it, and on the pass it may be a matter of importance to advertise the exact position of the boundary. Or (which is much more awkward) a self-contained basin, forming a small lake, the remnant maybe of an ancient glacier, which has no outlet either to right or left, may disturb the harmony of Nature's water-parting. The river, on the other hand, may possess valuable islands with channels of indefinite value on either side; the desert may contain a small oasis or perchance a well which may be all-important, and it may be crossed by more or less definite tracks; and the great ocean, as we shall see, may present more difficulties as a limiting geographical feature than all these others put together. A flat and marshy water-parting is most difficult of artificial demarcation, and is usually best left alone, but apart from the frequent occasions when natural features no longer serve, and artificial demarcation becomes essential, it is always necessary to study the geographical conditions of the land forms in order not to waste time and money to an indefinite extent in artificial decorations of those which are indisputable and unmistakable in their character of a boundary wall.

So far I have attempted to illustrate some of the many pitfalls which beset the path of the political arbitrator who is compelled to arbitrate without topographical maps, or who having topographical maps (not an uncommon case) is ignorant of the meaning of them. Now let me point out some of the more important difficulties which occur when maps are existent showing the general character and trend of the land-forms and otherwise sufficiently accurate for broad definitions. In this case, as in the case of an agreement based on fictitious geography, the difficulty has to be faced and the problem disentangled by the unfortunate demarcator, whose time may be lost in referring back to the seat of arbitration for a decision. First and foremost is the error of inexact geographical expression.

It is quite true that the nomenclature of geography is by no means fixed. Not long ago, at a meeting of the Research Department of the Royal Geographical Society, the subject was discussed after a most interesting and able paper by Prof. Davis. But it is not with reference to the actual definition of dispositions of nature in land formation that the difficulty to which I refer arises. It matters not much whether the technical classification of land-forms is genetic, based on the geological history of the formation, or whether it is simply physiological description expressing the character of the form in terms of its influence on other geographical features; whether the names of such features have a foreign derivation, or whether they are pure Anglo-Saxon, so long as the geographical definitions contained in the text of a boundary treaty are technically accurate and precise in their meaning. I assure you that the actual loss to this country, due to the promulgation of boundary treaties drawn up with little or no regard to technical accuracy of expression, can only be reckoned in millions of pounds sterling. If a man were making a will full of complicated provisions he would employ a lawyer armed with the full technical vocabulary of that rhetorical profession to make it for him. If he wishes to put a hedge between himself and his neighbour's estate even, he would take care that the agreement was correctly worded. But in defining a boundary between one nation and another, not even the most elementary knowledge of geographical nomenclature seems to be considered necessary. To take the case already quoted of the boundary disagreement between the republics of Argentine and Chili, when the treaties laid down broadly that the boundary was to follow the main range of the Cordillera dividing the waters of the Atlantic from the Pacific. What is meant in the first instance by a "main range"? Were these diplomatic representatives of two great powers aware that the actual backbone of a mountain system, that which by reason of continuity as a divide and general strike should be reckoned as the fundamental axis of the system, is frequently the oldest, the most disintegrated, and degraded; overshadowed by the magnificence of parallel ridges of possibly later formation, with the highest and most important peaks either decorating its own spurs (and thus carried on the crests transverse to the general strike of the formation), or else dominating distinct ranges? In short, the expression "main range" is geographically indefinite. Again, were the same high authorities aware that there might be no continental water-parting at all—no continuous line, that is to say, from which the waters on one side flowed to the Atlantic, and on the other to the Pacific? A broad, self-contained lake region in the middle of a continent is very apt to upset such a provision, and to a certain extent it did so. Let me say at once that the treaties were most ably prepared on the whole, and there were certain indications in them that these difficulties were not entirely unforeseen; but

the provision for dealing with them when they arose was quite inadequate.

I have said that a river may be an excellent boundary, but that it is a most undesirable feature to adopt under certain conditions. If both banks are occupied by undivided ownership; or if the river is liable to wide overflow in flood-time; if channels shift and change, and the river carves out new courses for its waters; if islands are submerged, converted into silt, and then reformed in new positions; in all such cases a river may prove to be a most fruitful source of dispute and litigation. The legal archives of Madras must be full of records of the disputed ownership of islands and valuable silt formations in the Godavari river, where some of the best tobacco of India is grown. What has been said of mountain ranges and of rivers may be said of almost any natural topographical feature. There is no law fixed and unalterable applied by nature consistently to the outward fashioning of her land formations, and it is the peculiar function of geography to insist on a careful and accurate illustration of all such formations, assuming nothing before applying the severe test of military movements or of political boundary-making. It is doubtful whether the worst disasters have resulted from geographical ignorance on the part of our military leaders, or from the blunders of our treaty-makers. Both have cost the country dearly. Let us hope that fresh light has arisen, and that if you, gentlemen, are hereafter entrusted with important functions as directors of armies, or as makers of diplomatic treaties, you will at least have learnt the great lesson of the value of accurate geographical definition.

On the nature of the illustration and the means of securing it, all of which practically is included in the science of map-making, I have no time to enlarge; but a word or two still has to be said about the all-important matter of accurate definition, especially as regards calling things by their right names. You may have all the information possible at your command; you may even have a fair map of the theatre of operations before you, and yet be guilty of loose expression or of ambiguous phrases, which may lead to most serious disruption when definition gives place to demarcation. I will give you an instance of my meaning. I was once concerned with a boundary which passed through open country —a country of hill and plain, where the hills were sharply defined in long and mostly continuous lines, sometimes knife-edged as to their summits, with steep rocky spurs rifted deeply by water-channels, and from the foot of the spurs there sloped away in smooth but often steep gradients the fans formed by detritus washed down from the mountain-sides, forming what is locally known in Baluchistan as "dasht." The "dasht" shaped into a broad smooth ramp, 7 or 8 miles in width, a prairie land of scrub and flower in spring, a wide expanse of stone-dusted slope in winter, which stretched between the foot of the mountain spurs and the meandering course of the nullah-bed which formed

the main drainage line of the valley. A very considerable length of the boundary which was to be based on the mountain range or ridge was defined as following "the foot of the hills." Here at once was opening for serious disagreement—and the disagreement promptly arose. What was the "foot of the hills"? Was it where the steep rocky spurs ended and the sloping grades of dasht began? Or was it where the nullah ran in the midst of the plain, and the slopes from the hills could descend no farther? In the latter case one would have thought that the boundary would have been defined by the actual nullah-bed. That was actually the interpretation maintained, and the interpretation threatened a frontier war.

Everybody remembers the Alaska boundary discussion, and the deep feeling of disappointment which was caused in Canada by the final award. The treaty-making in that instance was doubtless of somewhat ancient date, and the geographical conditions dealt with must have been, at the time the treaty was made, at least indefinite and hazy. But that was no reason for the employment of such an expression as the "shore" or coast "of the ocean" for defining a political boundary. What is the coast-line of the ocean when that coast involves an archipelago of islands, and is deeply indented with fiords or inlets? To include the islands would form a boundary impossible of practical demarcation; if the coast-line of each island formed a separate item in the boundary the intervening sea would be open. If an imaginary boundary were adopted in the sea and parallel to the general coast-line at a certain distance from it beyond the islands, the coast-line as a definition disappears. Or if, leaving alone the islands, the actual shore-line of the mainland (at low or high water) were accepted, where does it end as it rounds the inlets? There must be some limit beyond which it cannot penetrate into the interior. This is merely an illustration of an ill-considered use of the very commonest words. There is no technical difficulty. All that is wanted is the most ordinary knowledge of coast-line formations.

Once again I will take you into Asiatic highlands, where the Pamirs spread out their gently sloping flats and valleys under the shadow of well-defined mountain ranges. So vast and so rugged are these ranges that it is only here and there by grace of a glacial ramp that they can be ascended, and the connection between the triangulation which determined the points on which to base the Afghan boundary in these regions, and that which fixed the Himalayan peaks to the south was difficult exceedingly. However, it was accomplished, and Indian triangulation was carried on to the Pamirs and connected with the local Russian surveys. There was no room for argument about the initial position of the Russo-Afghan boundary, although it was based on a latitude, and although it was all-important that the value of that determination of latitude should be as exact as science could make it. There was the

triangulation to support the astronomical deductions. Thus all went well enough till approaching the end of the demarcation where the boundary was run to a junction with the Chinese frontier-line. Then came the trouble. The definition of boundary was as follows: "From this point the boundary shall run in an easterly direction to a junction with the Chinese frontier." What is an easterly direction? A little east of north? A little east of south? Due east? You will admit that this expression is sufficiently indefinite. In this case the interpretation involved the question of certain passes (whether they were of value or not we need not stay to inquire), but they were considered important at the time. The short summer and autumn were drawing rapidly to a close. Snow was settling deep on the passes India-wards, and it seemed probable that ere an answer to the simple question, "What is an easterly direction?" could be received, the camp of the commission would be snowbound in those vast altitudes, condemned to an Arctic existence for the next six months. Naturally there was no agreement between the Russian and British camps. And they arranged to separate for the winter. Fortunately, the weakness of geographical expression was recognized in time. It was so certain to lead to complications as to justify a reference to the high contracting authorities before those complications arose, and the reply, which determined the conclusion of the line on the basis of the actual topography, was received just in time to enable us to escape over the passes, already menacing and deep with snow, back to sunny India.

If, in pointing out to you just a few of the costly blunders which have beset the political efforts of our geographers of the past to arrange for boundary-lines in various parts of the world, I have appeared to call your attention to such elementary details as might seem subject to the application of the simplest common sense, involving no scientific insight, no appreciation of well-digested theories such as your studies here may develop, it is with the purpose of illustrating the value of even the most rudimentary study of geographical land formations. I have dealt with only one little hitherto unconsidered branch of the now widespread demand for more accurate geographical knowledge. It is even more particularly important in matters military or commercial, than in matters political; that is to say, the want of it leads to more actual positive loss to individuals and to the country. It is for you, gentlemen, in the future to take your place in the working world as soldiers, men of business, or diplomats, and if I have proved to you that quite apart from deep scientific research, or that higher knowledge which is only gained by a lifetime of study, a careful appreciation of the very simplest problems which geography offers may be of almost infinite value to you, I shall feel that I have not wasted your time.

THE REACHES OF THE UPPER SALWEEN.*

By ARCHIBALD ROSE, British Consul, Tengyueh.

In the autumn of 1908 two German travellers, Dr. Brunhuber and Mr. Carl Schmitz, set out from Rangoon, and, after passing through Burma, advanced from the Chinese frontier city of Tengyueh to the unknown reach of the Salween between latitudes 27° 15′ and 27° 30′, where they met their death at the hands of Lutzu tribesmen. Little, if any, of their work has at present been recovered, and lest all record of their labours be lost, I write this small tribute to the memory of two brave explorers.

High in the Tibetan uplands, amongst the river-sources of Asia, rises the Salween river, the great stream which in its southerly course forms a rough boundary between Burma and the Lutzu, Musso, and Liso tribes of the Chinese province of Yun-nan, and finally finds its outlet at Moulmein, on the Sea of Bengal. Much of the river has been explored, the late Mr. Litton, of His Britannic Majesty's Consular Service, with his companion, Mr. Forrest, having penetrated as far north as Lo-ma-de (lat. 26° 55′) in 1905, whilst Prince Henry of Orleans skirted some of the northern reaches in 1895, and other portions were crossed by Mr. E. C. Young in his journey to Sadiya. The stretch between latitudes 27° and 28°, however, remained practically unknown until the present year.

Early in December, 1908, Dr. Brunhuber and Mr. Schmitz set out from Tengyueh to ascend the river. For a few days they were accompanied by a caravan of pack-mules laden with tents and provisions, but the rough track proved that the passage of such an expedition would entail infinite trouble and delay. At Chengta the Chinese interpreter, in charge of the mules, was despatched to await them at Wei-hsi, on the river Mekong, whilst the two travellers pressed northwards along the west bank of the Salween, accompanied only by a young Madrassi cook, two Chinese muleteers in charge of the riding-animals, and twelve carriers for their baggage, recruited from the natives of the country.

After leaving Tengyueh little of the river-valley is subject to the direct administration of the Chinese Empire. With the torrential rains of summer heavy mists hang over the river-banks, and malaria and ague have long since taught the Yun-nanese highlander that he must relinquish this tropical valley as a home. In the months of the rains he can scarcely be induced even to cross the river, and as one passes by the bridge on the Talifu-Tengyueh high-road in the late spring, the last of the Chinese innkeepers are seen hurrying from their homes, which remain deserted until the autumn brings a clearer sky. The valley therefore has fallen to the lot of the wilder tribes, who have been pressed back by the Chinese in the struggle for existence, and the rich banks along the

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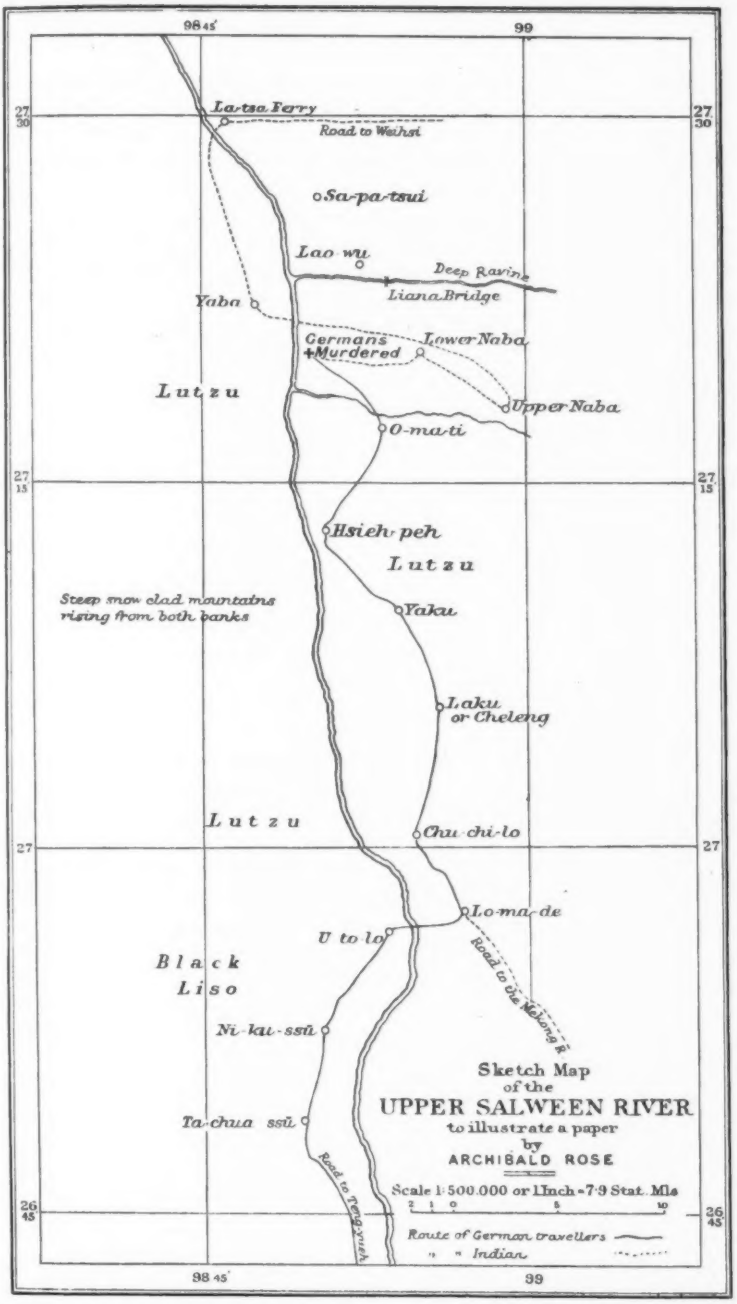

98 45'
99
27 30
La-tsa Ferry
Road to Weihsi
Sa-pa-tsui
Lao wu
Deep Ravine
Liana Bridge
Yaba
Germans Murdered
Lower Naba
Lutzu
Upper Naba
O-ma-ti
27 15
Hsieh-peh
Lutzu
Steep snow clad mountains rising from both banks
Yaku
Laku or Cheleng
Lutzu
Chu-chi-lo
27
Lo-ma-de
U to lo
Road to the Mekong R.
Black Liso
Ni-kai-ssŭ
Sketch Map of the UPPER SALWEEN RIVER to illustrate a paper by ARCHIBALD ROSE
Ta-chua ssŭ
Road to Tengyueh
Scale 1:500,000 or 1 Inch = 7·9 Stat. Mls
26 45
Route of German travellers
" " Indian
98 45'
99

southern reaches of the river are now cultivated by Shan farmers, whilst the northern stretches are left to the Liso, the "Lutzu" or Anung, the Tibetan tribes of Tsarong, and the Chiutzu of the west bank.

The travellers' first experience was in the territory of the "white" or tame Liso, whose country extends as far north as Hsia-ku-de (lat. 26° 25′), and who own allegiance to sawbwas or chieftains recognized by the Chinese Government, whilst beyond this point lie the villages of the "black" or wild Liso, entirely independent of the Chinese and of one another. In this country, however, the expedition appears to have experienced no serious trouble, save that the natives accompanied them unwillingly as porters, and the muleteers would often search through three or four villages before they could get a party together, whilst from Chengka to Lo-ma-de no provisions could be obtained. At this point, however, they crossed the river by the single rope bridge, already discovered by Mr. Litton, and they followed the eastern bank of the river for five days, through country previously uncrossed by any European traveller. They pressed on along the valley, which is filled with dense tropical jungle, where the track is choked with tough lianas, and mosquitoes and other insects are venomous and numerous, and they were often driven to the rocks of the river-bed when no other path could be found. On both banks were scattered villages inhabited by Lutzu, and high above the jungle rose steep snow-clad mountains, dividing them from China on the one hand and Burma on the other.

About the time of the New Year the expedition arrived at a little village called O-ma-ti, and here the porters were changed, the young chief of the village with eleven of his slaves undertaking the transport, and, in the hope of plunder, these porters appear to have intrigued with the neighbouring hamlets of Upper and Lower Naba and Lao-wu to stop their further progress. Shortly after leaving the village, two of the ponies were enticed away, and the muleteers, who set out to find them, were thus separated from the little party. During the day a sandbank by the river-side was reached, and here the tribesmen threw down their loads, refusing to proceed any further. They ascended to a village on the mountain-side, leaving the two travellers with their Indian servant to spend the night alone upon the bank.

The Indian climbed to the village to buy a fowl, and there he saw the porters talking and drinking with the villagers in a way that aroused his mistrust. He returned and related what he had seen, expressing his suspicions of the men; but Dr. Brunhuber reassured him, saying that the men were weary and would be all right in the morning. The travellers evidently feared no treachery, for they did not unpack the guns, which were in the porters' loads. Dinner was cooked and eaten, and after building up their camp fires, the three men went to sleep on their waterproof sheets, being too weary to pitch camp in spite of the winter weather.

The night passed quietly, but in the morning there was no sign of the muleteers or of the straying animals, nor did the porters come down for their loads. The travellers waited, hoping that their men would catch them up, and presently people began to descend to the sandbank from the village above. They came down about thirty of them, smiling and friendly, though all, even the boys, carried swords; and they offered a basket of rice and some eggs, receiving in return a present of foreign cotton, a pair of scissors, and a knife. Whilst the provisions were being packed by the Indian the savages crowded round the two travellers, who were some distance apart, Dr. Brunhuber having gone down to the river to wash his hands. They made two little groups, each with one of the travellers surrounded by twelve or fourteen of the natives. Suddenly one of the men raised a spear and stabbed Schmitz in the body, and he fell backwards on the sand. The others immediately fell on him, slashing at his body with their great two-handed swords. Brunhuber cried out, and one of the savages cut him down with a sword, making a great gash in his head. He had strapped his revolver at his waist early in the morning, but he had no time to fire before he was killed. Then the spoil was divided and the bodies thrown into the river, which at this point runs swift and deep, and thus ended the expedition of discovery, which was wiped out before its work was fully accomplished.

The Indian was bound and led into captivity, one of the Chinese muleteers was shot with an arrow through the eye before he reached the spot, the other was kept as a slave, and the booty was divided amongst the villages which had participated in the plot. For three months the young Madrassi was held in captivity at Lower Naba, at first bound hand and foot and surrounded by four men at night. Then they turned him into the fields to work with the women, who did all but the heavy ploughing on the rough hillsides. Crops of Indian corn, rice, and peas are grown on the hills, and in the warm clearings by the river tobacco is raised and dried for use, but they grow no poppy, and both opium and tea are unknown. They have crops of garlic, however, with mustard and a few green vegetables, and the lower villages are surrounded with fruit trees. Pigs, goats, sheep, dogs, and cows are kept, but pork is the only meat used by the people, and salt is unobtainable. They have long bamboo houses divided into four compartments, one of which is devoted to the women, and the houses are raised from the ground, being entered by a short stair, whilst the animals are kept in the space below. When the women are not in the fields they spend their time in cooking, or in weaving a coarse fabric from a species of wild hemp. The plant is boiled with wood ash to get the fibres, which are afterwards worked into threads and woven up for the long straight robes which are worn by the men over a pair of short breeches, without socks or shoes. The men wear a loop of silver, usually adorned with a cornelian, suspended over each ear; their ears are pierced also, and the rich insert a piece of

gold wire, the poor a piece of silver or even wood. They are beardless, and their heads are occasionally shaved, leaving a short queue at the back. The women wear a small coat with long sleeves and a short kilt, their only ornaments being a large silver earring with a pendant, and a cloth fillet studded with silver or cowries across the forehead, whilst their legs are encircled by numerous bamboo rings.

Their religion appears to be a form of Nât-worship, and they have occasional festivals, such as marriages and burials, when wild dances are performed to the accompaniment of guitars and bamboo instruments played with the teeth.

They have no lamps or candles, and at night the men sit round the fires, smearing their faces with lard and ashes, drinking deeply of their rice-spirit, and for ever plotting robbery and murder. Even the neighbouring villages are generally at feud, owing to cattle straying and cattle-raids, and the men go into the jungle to plunder the unwary traveller or harry the Chinese who border these inhospitable regions. They are armed with crossbows, swords, and spears, their arrows are charged with deadly aconite, and they carry a great ox-hide shield and a deerskin helmet, which will serve to turn an arrow from its course. The men are tall, strongly built fellows, and their evil reputation is not belied by their faces, which are of a low and brutal type.

After the Indian had spent three months at Naba he heard rumours that an armed force was advancing up the river, and, whilst working as usual in the fields, he was suddenly shot at and wounded with four arrows by his captors. He recovered from his wounds, however, and was carried across the river to a village on the west bank called Yaba, whence he was eventually ransomed—after five months in captivity—by the Chinese, and taken to La-tsa ferry, from which point they crossed the mountains to the Mekong and Wei-hsi.

Rumours of the murder of Dr. Brunhuber and Mr. Schmitz filtered by slow degrees to Talifu and thence to Tengyueh, where they were received on May 6, 1909, and an expedition was at once sent out by the Taotai to follow in the footsteps of the travellers to gather all possible information. A little band of twenty men, under the command of Colonel Chiang, pressed on as far as Lo-ma-de, and, in accordance with border custom, they were joined by levies of tribesmen as they passed through the Liso country, the Lao-wo sawbwa himself proceeding with the party from Chengka. At Lo-ma-de the horses and most of the transport were abandoned, in order to avoid all possible delays in the jungle, and in five days the expedition reached the group of villages which were reported to have been implicated in the crime.

The mountain village of Upper Naba was first approached, but the villagers retreated before the soldiers, who hurriedly burned a few houses, then followed the fugitives to O-ma-ti. Colonel Chiang's orders were to capture his prisoners alive, and, in the early morning, the

village was surrounded, and his men were ordered to advance without firing. They were speedily discovered, however, and a volley of poisoned arrows warned him that the men would not be taken without a struggle. Seeing a large force collecting, and realizing the weakness of his own band, he ordered them to open fire, and several of the villagers fell, whilst he pressed on and captured nine others, including the young chief. He then started in pursuit of the fugitives, who were escaping in the direction of Lao-wu, but he found his way blocked by a deep ravine, over which the villagers had crossed, cutting the liana bridge behind them. This ravine is reported to stretch into the mountains for many miles, and, fearing that his little band should be overpowered in this unknown and difficult country, and his prisoners rescued, he resolved to beat a hasty retreat. The villages are surrounded with buried stockades of sharpened bamboos, and in his attack on O-ma-ti, one of these stakes pierced Colonel Chiang's straw sandal and entered his foot. Fearing that the tip might be poisoned, he adopted the heroic measure of cutting away the wounded flesh with his sword, and I think it was not without a touch of pride that he presented himself on his return to have the wound dressed and bandaged.

After the capture of the prisoners the party retraced their steps along the Salween as far as Lo-ma-de, then struck eastwards across the mountains to Ying-pan-kai on the Mekong, whence they returned to Tengyueh without the loss of a man, though the little troop had been severely tried by wounds, fever, and the hardships of a forced march through the Salween valley, a region which has a superstitious terror for the Chinese at all times, and of which the dangers and difficulties had been intensified by the heat and the torrential rains of early summer.

My information of the Lutzu country and its wild tribesmen has been gathered from the young Indian, from a Liso tribesman, who spent his youth among them and who speaks their language, from the Lao-wo sawbwa, and from Colonel Chiang. From their accounts I have built up the accompanying sketch-map, showing the routes taken and the approximate positions along the track between the known points of Lo-ma-de and La-tsa ferry. I cannot hope that it is more than approximately correct, but it may prove of interest in tracing the last marches of the two courageous men who have been the first to penetrate the ill-famed land of the Lutzu, and who appear to have been within two marches of the point whence they would have rejoined their main caravan, and lifted the veil from this unknown reach of the upper Salween.

MR. J. W. BROOKE'S JOURNEYS IN WESTERN SZE-CHUAN.*

By C. H. MEARES.

THE late J. W. Brooke started (March, 1908) from Chentu, the capital of Sze-chuan, with the object of mapping and exploring the country called the land of the eighteen tribes, which lies between Sze-chuan and the Tibetan frontier. Some four hundred years ago the Chinese tried to drive out the aboriginal tribes of this country, but being unable to overcome them in their mountain strongholds, they persuaded some tribes to come from Eastern Tibet and attack them in the rear. These tribes did so, and when they had driven them out they occupied the country, and have held it ever since nominally under the Chinese. There are still a few people left called the Chang Ming, who are without doubt a remnant of the ancient inhabitants.

This country of the eighteen tribes is one of great interest on account of its natural features, including snow ranges which are only surpassed by the Himalayas; its strange and little-known animals, such as the takin, serow, goral, parti-coloured bear, golden monkey, etc.; its flowers, birds, and butterflies, and its inhabitants, which have a special interest for the student of anthropology.

Making his headquarters at Wen-chuan, a village four and a half days' march north of Chentu, on the banks of the Min, in the midst of the mountains, Mr. Brooke spent some weeks hunting with the Wassu tribe, whose chief lives near here; he also spent some time taking observations and fixing the positions of the principal peaks. We shot specimens of the takin, serow, goral, parti-coloured bear, golden monkey, etc., all of which were sent to South Kensington. Mr. Brooke's mapping was all done with a plane-table filled in in places with prismatic compass work, and he fixed positions from time to time by sextant observations of the stars; his altitudes he got with a boiling-point, and he carried aneroids as well.

He started from Wen-chuan in May, with Mr. Fergusson of Chentu and myself. From Wen-chuan we went north to Wei-chou, and then west to Lipan, where the Chinese official lives who is supposed to be in charge of these tribes. We asked this official to give permission and assistance to travel among the tribes, but the official said that he could not do so, and showed an order he had received from the Viceroy, saying that on account of the behaviour of certain Europeans on the Tibetan frontier no foreigners were to be allowed to travel in the country. However, after some talking he gave us a letter and an interpreter, taking the responsibility on his own shoulders. Here we met Colonel Gow of Zakalao, chief of one of the Chang Ming valleys, who had known Fergusson before; his sister was married to the chief of Danba, and he gave us letters of introduction to all the chiefs.

* Map, p. 704.

Shortly after leaving Zakalao, we left the country of the Chang Ming and entered the country of the tribe under the Somo chief. At the first large village, Miala, the people were unfriendly, but afterwards they improved. We next crossed the Chikku pass, 12,000 feet, but easy to cross. On reaching the other side, we found that the village of Matang was occupied by the chief of the Heisui and a number of his followers. The Heisui are related to the Golok; they are notorious raiders, and we expected trouble, but all passed quietly. When we returned later we heard that they were at war with the Chinese. From Matang we marched through beautiful country to Somo, where the castle of the Somo chief is situated. The people were quite friendly, but the chief was afraid to see us because of the evil eye. From Somo we came to Drukagi, the chief of which is a lama. A small Chinese official had passed through here a short time previously, and had told the chief to take guns and drive back any foreigners who entered the country. The people were not very friendly. From here we went to Rungkang, which is ruled by a chieftainess. The people were friendly, but rather frightened; however, a number came for medicine, as they did in all the places.

From Rungkang the road leads over two passes, the first of which, Piaowa pass, is rather long and tedious, 13,500 feet. At Danba we met our friend Colonel Gow, and had a great reception; the people all came down in their best clothes and prepared a big dance, but, unfortunately, just as they were beginning word came down that some robbers were raiding their cattle, so the dance was broken up, much to our disappointment. From Danba we descended to the valley of the Kermer. We crossed the river in a coracle. This valley is wonderfully fertile. Chosschia is situated on a tributary of the Kermer. Foreigners who had tried to enter there before had found the people hostile, but we had a letter from the Danba chief, and received a friendly reception. The chief was afraid to see us, but sent presents, and offered to send us on through the tribes to the west. Here we agreed to separate, so I took the coolies and baggage and travelled down the valley of the Kermer, or D a Jin, as it is now called, to the Chinese settlements of Hsu-chin and Tunghua. From Tunghua I struck south-east to Mungung over the Keng-kia pass, which was a long and tiresome climb, with deep snow on the south slope. All the coolies were prostrated with mountain sickness. Unfortunately, I had no hypsometer, but I should say that it was certainly 16,000 feet. I reached Mungung, which is the Chinese headquarters, and consists of two towns about a mile apart. Mungung is the official town and Shingai-tze the business town. From here I went to Chanku, a town at the junction of the Hsia-chin and Da-chin, where I expected to find Brooke and Fergusson, but got a note from them saying they had gone further west; so I visited the beautiful country of Bawang and Badi.

Badi in particular is interesting, as it is a centre of the black lamas,

and there is a great black temple, which I tried to enter, but in vain. The dress of the girls in this country is very strange, and consists only of a small piece of cloth hanging down behind, and a fringe of strings hanging down in front. I returned to Mungun, and travelled about in the neighbouring country till I was rejoined by Brooke at Mungung.

After separating from me at Chosschia, Brooke and Fergusson hired yaks and ponies, and struck westward into the grass country. The first day west of Chosschia was through grassy valleys; the second day they crossed a pass 13,700 feet, but the slope was easy. They reached Akree, which consisted of a fine monastery and some houses. Next day they crossed rather a steep pass and reached the Masha lamasery, where they stayed till they got escort to take them on to Damtong. The girls in this part of the country wear a dress similar to that worn by the girls of Badi; they do their hair in two plaits hanging in front of their shoulders, and a short plait hanging in front of their noses, with a bead on the end; they also wear a conical felt hat like the old Welsh hat. From here they crossed another high pass and came to Damtong, the capital of Kaishechia; it is situated in the fork of two rivers, and consists of a number of stone houses and the castle of the chief. They found that the chief here was doubled up with rheumatism, and had not left his bed for some months; they massaged him with vaseline and alcohol for three days, by which time he was able to walk about without the help of a stick. The lamas were filled with consternation, and thought that it was a miracle. After this the people were very friendly. In this country the people all belong to the Black lama sect, but the adjoining country of Uko has a separate religion of its own; the inhabitants are nomad robbers, and it is under the government of Lhasa.

After leaving Damtong, they passed through fine grazing country with numbers of splendid ponies and cows, and reached Uko monastery, where they found the people very unfriendly. After leaving Uko monastery, they crossed another high pass and reached Dawo, where there is a small Chinese official, and a population of about three thousand people. There they got letters of introduction and escort to take them through to the Janguay country and Derge, on the road to Jerkundo. But as they were short of mapping material and provisions, and as it would be a journey of about two months' duration, they reluctantly had to abandon it. They then continued their march to Tachen-lu, passing through Tieling, where a new lamasery has been built in place of the one which was burnt down by the Chinese punitive expedition some years before. After leaving Tachen-lu, they followed the main road to Wassukou, and then took a small road north to Mungun. This road took them through the most magnificent scenery they had ever seen, and they followed up the stream till they reached the watershed of the district at Liang-ho-kow, where they spent some days shooting burul

and trying to find me. In the mean time, I had come south from Mungun over a very high pass called Seping, from which I had a view of hundreds of snow-peaks though it was August, and then came down through a thickly populated district where no foreigner had ever been seen. Brooke and I then met in Mungun, and Fergusson returned to Chentu by the straight road. From Mungun Brooke and I went north along the valley of the Hsiao-chin to Fupien, a chinese town, and thence to Liangho-kou. Just to the east of Fupien is a peak which must be one of the highest peaks in the country: we could never get close to it, but got bearings on it from Chentu and other places. Seen from Chentu, it seems to tower high above the intervening mountains, and must be quite 25,000 feet. Among the mountains which rise above the valleys are to be seen some splendid cliffs of clear ice several hundred feet thick. After crossing the Hungchia pass, 15,000 feet, we returned to the road by which we had started out. On the Hungchia pass Brooke found the large blue poppy which was seen by Prjevalsky many years ago, but had not been heard of since. After this we spent some time hunting takin, etc., near Zakalao. We then went to examine the fossil beds at Sanchiang-hou, and returned to Chentu to refit for our next expedition. During this expedition, Brooke, in addition to his mapping and observations, had made a good collection of photographs, and also collected the plants and butterflies of the district.

On the next journey his intention was to go south to Ningyuanfu, then make a trip into Lololand south of Ningyuanfu, thence north-west across country to Batang, and then go as far as possible in a south-westerly direction towards Rima. We went down by boat from Chentu to Chiating, whence we went to Omieshan. On our way back we spent some days examining the prehistoric cave-dwellings in the red sandstone cliffs, and were fortunate enough to discover a number of terra-cotta figures and objects of interest. These figures show a state of considerable civilization and artistic talent: they have been sent to the British Museum, but it is impossible to discover who these people were. Strange to say, some objects which were discovered in the ancient dolmans of Japan are almost identical. From Omieshan we went to Yachow, and then down south along the main road to Ningyuanfu. After crossing the Tung river at Fulin, the road runs through a narrow strip of country held by the Chinese, while the Lolos hold the hills on both sides and constantly raid the road and the villages along it; they burn the houses and carry off the inhabitants to be slaves. We travelled along through most beautiful and fertile valleys, and reached Ningyuanfu without incident on December 4, and on arrival there we found that the third member of our party was delayed; so Brooke said that he would make a short trip to the Lolo border, prior to our main trip, to get some photographs and see whether the Lolos

were friendly. At that time we understood that the Lolos were well disposed to foreigners, so did not expect any trouble from them; Brooke said that he might be out for two weeks, or he might return in two days. As he wished to attract as little attention as possible, he only took his interpreter and a few coolies, and asked me to remain at Ningyuanfu to develop photos and look after the rest of the expedition. As time passed and we got no news from him, we began to get anxious, so we sent out natives with letters to find out in which direction he had gone. After some time, they came back with word that they had not seen Brooke, as he had gone further into the country and had been well received by the chiefs. This removed our anxiety, as we thought that he had crossed the country, and it had taken him longer than he expected to return. As we still got no news, we sent in more natives to follow him further; and after some days they brought back word that he had been killed. It was impossible for us to get into the country to recover the body, so we sent in natives; and after a long time the body and two survivors were recovered. The stories of both these men agree. Details as to the murder of Mr. Brooke were given on p. 340 of the *Journal* for September, 1909.

COLONIAL SURVEYS.*

By Captain H. L. CROSTHWAIT, R.E.

Surveys, and their resulting maps, are works of such great public utility, both for civil and military purposes, that it is not easy to understand how countries, which have been under our flag for many years, remain so long without them. The Ordnance Survey of the British Isles owes its origin to the rebellion in the Highlands of Scotland in 1745, and the consequent discovery of the deficiency of geographical knowledge, then felt, perhaps, for the first time. The work was actually begun in 1747. About this period, General Roy, the father of the Ordnance Survey, wrote, "If a country has not been actually surveyed, or is little known, a state of warfare generally produces the first improvement in its geography."

In the case of Africa history repeats itself. The cause, more responsible than any other, for the present impetus to mapping in Africa, the effect of which is being felt in varying degrees throughout the Empire, was the war which began in 1899. It would seem, therefore, that General Roy's words, though written so many years ago, still hold good. The South African war was, without doubt, the

* Colonial Reports—Annual, No. 608. The Annual Reports of the Colonial Survey Committee. Wyman & Sons, Ltd. *Price* 1s. 7*d.*

principal factor, though perhaps not the only one, that called attention to a state of affairs which, in time of urgent need, found large and important areas without maps of any practical value. Those responsible for the administration of new countries have, as a rule, but a scanty revenue to meet many claims on expenditure. Those claims which are considered most pressing are placed first. Expenditure on survey often assumes an unremunerative aspect, or at least one which will not show any immediate return; consequently it frequently occupies a very secondary place on the list, if it is found there at all.

But the reports of the Colonial Survey Committee bring out very prominently how shortsighted a policy it is not to undertake the mapping of a country at the earliest possible date, and not to place expenditure on this object before many others with only apparently more urgent claims. In East Africa, one report says, "The absence of survey has led from one difficulty to another. The land in some districts is said to have been applied for many times over; other districts partially settled have been closed for further settlement; other districts, again, have not been open for settlement at all. . . . As a consequence, the general development of the country has received severe check. The necessity of seriously and at once dealing with the question of survey cannot be overestimated." *

While the South African war brought out prominently the deficiency of maps in that quarter, we may enumerate, among other reasons which necessitated surveys in different parts of Africa, "the allotment of estates to chiefs and landowners, in accordance with the Uganda Agreement of 1880;" † "a vigorous survey of the Gold Coast Colony was rendered necessary in 1901, on account of the large number of gold-mining concessions taken up by companies." ‡ Then, again, the defeat of the Khalifa opened up to survey operations a new, and little-known country of nearly a million square miles.

In another category come the numerous boundary commissions concerned with the settlement of the international frontiers of Africa, from 1890 down to the present time. In the course of their labours it has been found necessary to survey and explore, in the aggregate, very large areas. It soon became imperative to place the general control of so many and various operations under some technical central body. The annual reports of the Colonial Survey Committee for the last four years now lie before us. The committee was formed by the Secretary of State for the Colonies in 1905, "to advise him on matters affecting the survey and exploration of British colonies and protectorates, more especially in Tropical Africa;" and "to make such recommendations as will ensure the rapid and economical prosecution of accurate surveys where these are

* Report, 1906-07, p. 27.
† *Ibid.*, p. 51.
‡ *Ibid.*, p. 30.

required, and the rendering the results available as speedily as possible for the use of the Home Government, the Colonial Governments, and the public."* It consists of a representative of the Colonial Office, the Director-General of the Ordnance Survey, and the officer in charge of the Geographical Section, General Staff. Under the guidance of a committee of this kind, it has been possible to produce African maps on a uniform system. A uniform plan of numbering, based on the General Staff map of Africa, on a scale of 1 : 1,000,000, has been adopted for the whole continent. This would hardly have been possible except under the direction of some central body. Then, again, a uniform set of scales for topographical maps has been arranged, all of which are multiples of the standard million scale.

While the committee was originally concerned with British Africa alone, it now advises on, and reviews annually, the survey operations in Ceylon, the Federated Malay States, Jamaica, Trinidad, British Honduras, and Fiji. It is, therefore, possible to ascertain the progress of surveys, both topographical and cadastral, in a considerable number of colonies and protectorates, and to arrive at the exact state of the mapping in each area, together with other fundamental operations connected with the work.

The latest report shows that during the year ending March, 1909, 28,000 square miles have been topographically surveyed in British Africa, exclusive of boundary commission surveys. The largest outturns were in the Cape and Orange River Colonies, of 14,500 and 7000 square miles respectively. This brings the total for the last four years, in the South African colonies, that is, since the commencement of the work, up to 113,000 square miles, on the $\frac{1}{125000}$ and $\frac{1}{250000}$ scales. While great credit is due to all concerned, this large outturn is partly owing to the nature of the country in South Africa being generally favourable to rapid survey operations, and to a comparative absence of detail. In the Cape the field work was carried out by a party of officers, seconded from their regiments, under a Royal Engineer officer; while in the Orange River Colony the Colonial Survey Section of the Ordnance Survey was utilized.

Two boundary commissions were in the field: the Anglo-German Yola-Cross River Commission (British Commissioner, Lieut.-Colonel G. F. Whitlock, R.E.) and the East Africa-Sudan-Abyssinia (British Commissioner, Major C. W. Gwynn, C.M.G., D.S.O., R.E.). The area surveyed and explored by these commissions amounted to 34,000 square miles.

We may here draw attention to the very beautiful model of Mount Ruwenzori, which has been constructed, in the Geographical Section of the War Office, from the maps of the Anglo-Congolese Boundary Commission of 1907–08, a photograph of which appears as a frontispiece to the report.

* Report, 1905–06, p. 30.

A tabular statement has been prepared showing, in a concise form, the progress of the delineation of British frontiers in Africa from 1890 to date.

A number of index-charts are bound with the volume, indicating those maps in progress and already published, from which the sheet number and scale of any desired map can be obtained. In connection with the general progress now being made throughout the empire, it may be mentioned, though not referred to in this report, that the Militia Department of the Dominion of Canada is producing some excellent maps on a 1-inch and ½-inch scale.

The geodetic work of the year is represented by the measurement of a section 165 miles long, extending from 1° 10′ N. to 1° 10′ S., of the Great Arc of the meridian of 30° E. As this portion of the arc falls partly in the Congo State, its measurement was undertaken by a joint British and Belgian party. Contributions towards the expense of the undertaking were made by the Royal Society, the Royal Geographical Society, the Royal Astronomical Society, and the British Association. A base of 16,532 metres was measured in the Semliki valley by means of Invar wires. The time required for this operation was only thirty-eight days. Two 10-inch Repsold theodolites were used for the triangulation.

Technical details are naturally avoided, as they would be out of place in these reports. But one cannot help thinking that if the committee could arrange, with the different bodies concerned, for the separate publication of the more elaborate accounts, descriptive of the actual methods adopted in the field, they would, from the great variety of country which has to be surveyed, form a most useful guide to others engaged in similar work. For instance, we should like to know details of how the very accurate traversing, used as a substitute for triangulation in the dense jungles of the Gold Coast, was carried out. Then there is the system "minute squares," adopted for certain cadastral surveys in the Sudan, incidentally referred to in the report. But without details we do not know what the special advantages of this method are, which seems to be a departure from the usually accepted principles of survey.

These are only a few examples of how a detailed account might be made useful to surveyors in other countries. The mere mention of these, and other matters, makes us wish to know more. It is possible accounts have been published, in which case, perhaps, reference footnotes might be added to the Annual Report.

The committee are certainly to be congratulated on the order and system they have succeeded in introducing into Imperial Surveys.

REPORT OF PROGRESS IN THE INVESTIGATION OF RIVERS.*

By Dr. AUBREY STRAHAN, F.R.S.

THE EXE AND ITS TRIBUTARIES.

THE first report on the investigation of rivers was read before this department about a year ago. We now again present an interim report, and not the final one, inasmuch as the investigation will proceed so long as the funds last.

The four water-level gauges previously established in the Exe system, viz. at Exeter quay, Brampford Speke, Pynes bridge (on the Creedy), and Silverton mill (on the Culm), have been read daily since the date of the last report. For the reading of the last-mentioned the committee is indebted to Mr. Charles Gray, engineer to the mill. Hourly observations also have been made on the fluctuations of the water-level during periods of flood or rapid change, but much difficulty has been experienced in getting observers to understand that the highest level of the highest flood is not the only observation which is desired. Many more records are necessary to enable the passage of a flood down the river, and the modifications in the form of the flood-wave, to be traced in detail.

Velocity-observations have been made by Mr. H. O. Beckit and Mr. G. E. L. Porter on the Exe and Creedy, on the courses already measured. Hitherto no velocity-course had been measured on the Culm, though the channel had been examined more than once for the purpose of selecting a suitable site. No site suitable in all respects, and accessible in all conditions of the river, exists, but at a point about half a mile above the junction of the Culm with the Exe, a course which will be accessible except when the river is in flood has been measured, and observations on velocity have been made by Messrs. Beckit and Porter. A difficulty which exists in the case of the velocity-course on the Creedy, namely, that the water is liable to be backed up in the Creedy by a flood in the Exe, cannot be overcome. It is hoped that when such circumstances arise, a course higher up the Creedy may be found to be available.

With respect to the examination of the water of the Exe, Creedy, and Culm, Prof. Lewis reports that he has arranged for the collection of water at Brampford Speke whenever a flood may occur, and for the collection of samples of the Creedy water above Pynes bridge. The following samples have been collected and examined since the date of the last report:—

January 1, 1909. Brampford Speke: gauge-reading, 4 feet; suspended matter per 100,000, 0·89.

March 10, 1909. Brampford Speke: gauge-reading, 2 feet 6 inches; suspended matter per 100,000, not weighable.

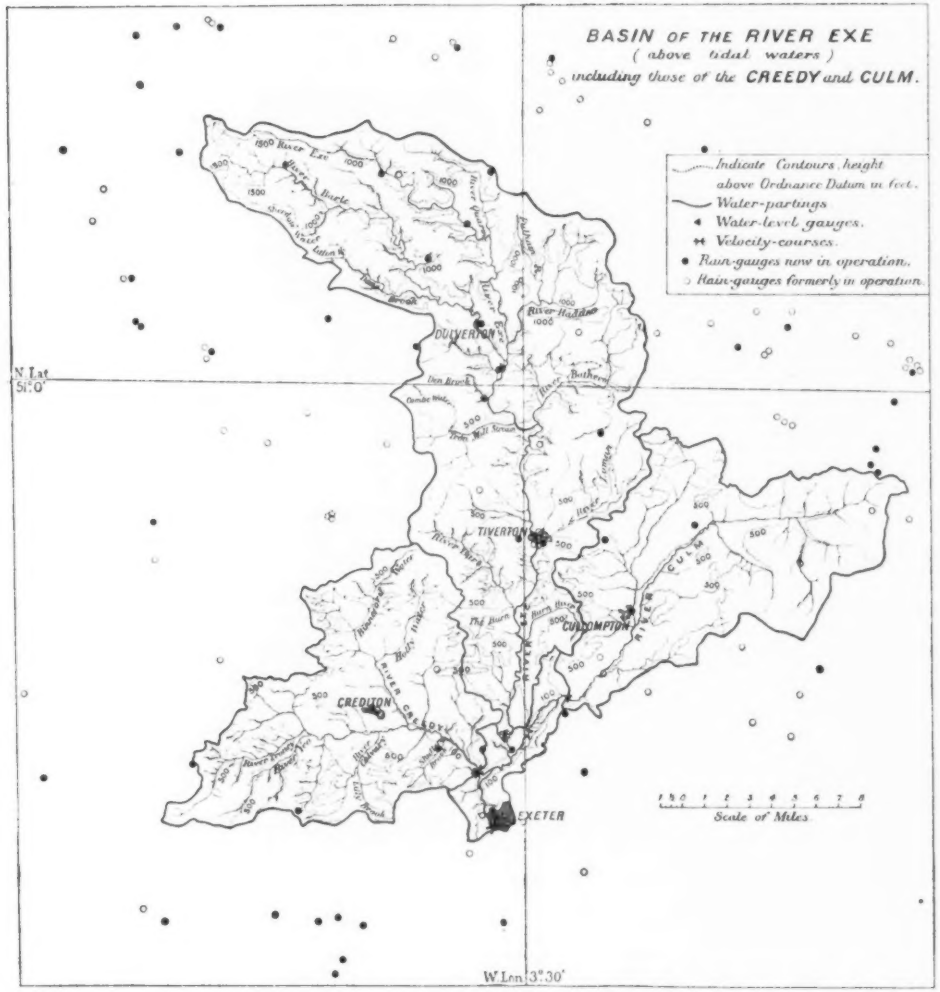
March 10, 1909. River Creedy: gauge-reading, 4 feet 6 inches; suspended matter per 100,000, 14·6.

There is no doubt that more frequent observations on the suspended and dissolved matters in these waters are desirable, and Prof. Lewis expresses the hope that it will be possible to do much more in the coming twelve months than was accomplished in the previous period.

A difficulty arose in the case of the Creedy in consequence of the backing-up of the water by the Exe, as already mentioned. It is for this reason that the samples

* Research Department, May 20, 1909.

MAP I.



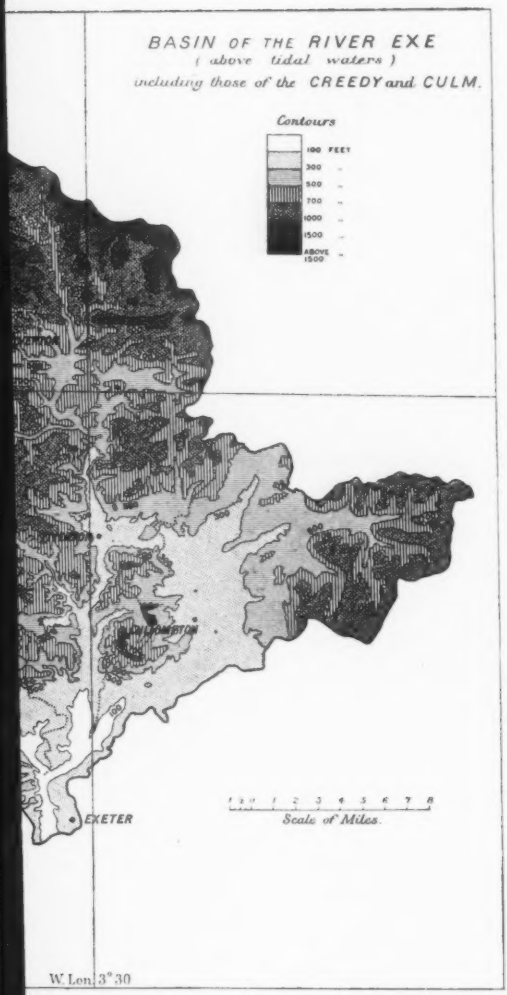
BASIN OF THE EXE—RIVER COURSES AND GAUGES.

MAP

BASIN OF THE EXE—

THE EXE BASIN.

MAP II.



THE EXE—OROGRAPHICAL.

[*To face page* 622.

will be collected above Pynes bridge, above the point which the Exe water can reach. This will be done by the kind co-operation of Colonel Wyatt Edgell.

No samples have been received from the Culm.

The measurement of the Exe basin by Mr. G. F. Elton is proceeding. He reports that out of 113 6-inch sheets, coloured geologically (as far as is necessary for the purposes of this investigation), 63 have been measured. Out of 7 1-inch sheets, on which areas between contour-lines 200 feet apart are being measured, 4 are finished.

With the assistance of Mr. H. O. Beckit, Mr. Elton has examined wherever necessary, and drawn on the 6-inch maps, the boundary of the Exe drainage-system (exclusive of that part which drains into tidal water), and the partings between the Exe, Culm, and Creedy. Three maps of the Exe basin are now complete, viz.—

1. Map showing the water-partings mentioned, the position of every stream-course and its name, the position of the Committee's river-gauges and velocity-courses, and of all rain-gauges within or near the Exe basin.

2. Map showing the 100-feet, 300-feet, 500-feet, 700-feet, 1000-feet, and 1500-feet contours, with the interspaces distinguished by tint, and the water-partings mentioned above.

3. Map by Dr. H. R. Mill, showing isohyetic areas.

THE MEDWAY.

The irregularities in the clocks of the automatic gauges, which were interrupting the record at the time of the previous report, having been remedied, continuous records have been obtained for several months, and are still being maintained. The determination of the relative level of the two gauges was undertaken by Mr. MacKenzie, no local surveyor having been willing to guarantee sufficient accuracy. This work was carried out with the assistance Mr. J. H. L. York and General Chas. Strahan, R.E. Some cross-measurements of the channel, and observations on velocity, were also made by Mr. MacKenzie (see *post*, in Note on Discharge Tables).

The collecting of samples of water for examination was not being carried on satisfactorily, and in April last fresh arrangements were made, as a result of which it is hoped that there will be no further difficulties on this score.

The examination of the water has been kindly undertaken by Mr. R. C. Wells at the Technical Institute at Gillingham, who reports that on June 16 at 11.15 a.m. he found 24·38 parts dissolved matter per 100,000, and on August 29 at noon 22·54 parts per 100,000, with no suspended matter in either case. A discussion of the utilization of the data collected on the Medway, in regard to the calculation of discharge, will be found in the Note on Discharge Tables, by Mr. MacKenzie. The tracing of the water-parting of the Medway basin, and the measurement of its area, of the areas occupied by pervious and impervious formations respectively, and of the areas which lie between certain contour-lines, has been undertaken by Mr. E. W. Dann, whose report of progress is appended.

THE SEVERN.

In anticipation of the desirability of extending the inquiry to the Severn, the Severn Commissioners were approached in October, 1908. As a result permission was kindly given to the Committee, not only to use the daily readings of gauges which are made at Worcester and elsewhere, but to arrange for the collection of more information through the lock-keepers, provided that all expenses were defrayed by the Committee.

Mr. G. F. Deacon, whose gaugings of the Severn were alluded to in a previous report, has been so kind as to place the results at the disposal of the Committee. The

gaugings were carried on with great detail in February and March, 1880, and if, as appears probable, the channel has not changed, the observations then made on the relation between water-level and discharge will still hold good. Mr. Deacon also furnishes a chart showing the daily discharge from June, 1878, to December, 1889. The examination of the water was kindly undertaken by Dr. G. H. Woollatt at the Victoria Institute, Science and Technical Schools, Worcester, whose report follows.

NOTE ON DISCHARGE TABLES.*

By N. F. MACKENZIE.

I HAVE this afternoon to report the progress made towards the completion of discharge tables for the Exe and Medway rivers.

On the Medway we have two self-recording gauges about 2 miles apart, and as these were fixed without any reference to their respective levels, it was necessary to determine the relative levels of the gauge-zeros. I undertook this work with the assistance of General Strahan and Mr. Yorke, and without going into details I may say that the relative levels of the zeros have been determined with a possible error of 0·01 foot. For a distance of 2 miles I look on this as satisfactory, and do not think we can hope for anything better. I therefore accept the gauge-levels as final.

From the gauge-records we can work out the surface-slope of the river, and use this slope to calculate the discharge from Kutter's formula. To do this we require to know the value of the "coefficient of rugosity," and this is determined by measuring discharges of the river by the surface-float method, and from these measured discharges calculating the appropriate value of N, the coefficient of rugosity. Incidentally, we required several cross-sections of the river, and these have been determined.

Having got the necessary data, we are in a position to solve Kutter's formula for any required slope and gauge-reading. Kutter's expression for the discharge is of the general form common to a great many of such formulæ, viz. $Q = C \times A \sqrt{RS}$, where C = the coefficient of discharge, a somewhat complicated expression, A = area of the cross-section, R = its hydraulic radius, and S = slope of the water surface in unit length.

I have drawn up four tables for the Medway. Table I contains, for all the gauge-readings we are likely to require ordinarily, values of A, R, and $A\sqrt{R}$. The gauges are taken at 3″ intervals, and other values may be got by interpolation.

The next step is to reduce the formula to a form suitable for interpolation. Table II contains values of all the constants in the formula, combined with one variable, the surface-slope. The slopes run from 0″ to 3″, and are taken at intervals of $\frac{1}{5}$″ in the lower values, and $\frac{1}{4}$″ in the higher values.

Table III contains values of C, the coefficient of discharge, for twenty-five different gauge-readings at 3″ intervals and for slopes varying from 0 to 3″. It is got by combining the results in Table II with the second variable, viz. $\sqrt{R}$.

Table IV is a table of final results giving the discharge of the river for various slopes and gauge-readings. It is got by multiplying together for each slope and gauge reading the values of C (from Table III), $A\sqrt{R}$ (from Table I), and $\sqrt{S}$ (from Table II).

To use these final tables, we take from the gauge-records the mean of the two

* The discharge tables and curves referred to in the "notes" may require modification when the information on which they are based is complete. They will be published in their final form only.

gauge-readings, which I have called the mean gauge; we then take the difference of the two readings, and apply the previously determined correction for difference of zero-levels, this gives the surface-slope. The appropriate discharge for the given mean gauge and surface-slope is got directly from Table IV. The preparation of the tables necessitates a large amount of computation, but the intervals have been taken sufficiently close together to permit of interpolation when necessary.

These tables would be final but for the value of the coefficient of rugosity, N, about which I am a little doubtful.

My measured discharges give N = 0·035, which is by no means an impossible or even an improbable value, but indicate that the *régime* of the river is somewhat worse than appears to the eye. The coefficient I had selected before taking my observations was 0·030, and though I have no reason to doubt the correctness of my data, yet there is a possibility of error which must be kept in mind. The measured discharges were taken with rather low gauges, giving a surface-slope of about $\frac{3}{4}''$ in 10,000 feet. It will be remembered that there is a possible error of 0·01 foot, or $\frac{1}{8}''$ in the levels of the gauge-zeros, and this is enough to render doubtful a value of N based on observations with very low slopes. I wish, therefore, to check the value of N by measuring a discharge in flood-time, or, at any rate, when the river has a much greater surface-slope than it had when the former discharges were taken.

In the mean time I have compiled two tables of final results, one for N = 0·035, and the other for N = 0·030; it is fairly certain that the true value of N lies somewhere near or within these extremes. When the value of N has been finally accepted, it will be easy to interpolate a final discharge-table, so that the calculations already made are not thrown away.

I may mention that though there is no great numerical difference between 0·030 and 0·035, yet the final results differ by about 12 per cent., which is a much greater error than we can accept.

To sum up: the experimental work remaining to be done on the Medway is to measure one or more discharges when the river has a considerable surface-slope. When that is completed, the daily, monthly, or annual discharge of the river can be worked out.

I have calculated one or two Medway discharges from two other well-known formulæ, to see how they agreed with the results got from actual measurement.

The first formula was that of Bazin, and the calculations confirm what is generally recognized, viz. that the formula is not well adapted for dealing with very small surface-slopes.

The second formula was that of Humfreys and Abbot, of the United States Corps of Engineers, which is specially suited for large rivers with small slopes, being based on their work on the Mississippi.

The general Mississippi formula is known to be suitable for rivers of the Mississippi type, and the authors deduced from it another formula suitable for rivers with small slopes and a hydraulic radius of less than 15, *e.g.* the Medway.

This deduced formula was the one I used for calculation, but I find that the results do not agree with actuals so well as those calculated from Kutter's formula. This supports the opinion I originally expressed, that we should use Kutter's formula for the Medway discharges.

There is one important point connected with the Medway discharge-tables which requires discussion. When we have arrived at final results, at what time-intervals should the gauge-readings be taken in order to calculate the total discharge for a week or for a month?

The gauge-readings are constantly altering; they seldom remain steady for even

one hour; and evidently, the greater the number of gauge-readings we take into account in computing a total daily discharge, the more accurate will be the result. The spaces on the gauge-records which represent time intervals are sufficiently large to permit of readings at intervals of 15 minutes, but to arrive at a total monthly discharge by computing 96 discharges for each separate day, means a prohibitive amount of calculation, and is, I believe, unnecessary.

I have calculated the discharge of the Medway for one week, taking the gauge-readings at intervals of one hour, and also at intervals of three hours. The results compare as follows:—

The total daily discharges as got by the two methods differ by from 3 per cent. up to, in one case, 10 per cent. When, however, we take the total discharge of the week, we find that the daily differences tend to cancel each other; and in the particular case which I worked out, the results were practically identical, the difference being less than one-quarter per cent.

The conclusions I draw from the calculations are—

1. When for any purpose we require the discharge of a single day, the gauge-readings should be taken at one-hour intervals.

2. When total weekly, and, still more, total monthly discharges are required, the gauge-readings taken at three-hour intervals will give results quite as reliable as if they were taken at one-hour intervals.

I have never had to deal with a river subject to such rapid fluctuations of level as the Medway, and I should be glad to have my proposals criticized.

NOTE ON THE DISCHARGE CURVES FOR THE EXE AND ITS TRIBUTARIES.

In working out a discharge-table for a river on which gauges only are recorded and not surface-slopes, it is necessary to have a series of discharges measured at different gauge-intervals, and from these measured discharges the discharges for intermediate gauges can either be calculated, or, preferably, determined by means of a discharge-curve. A discharge-curve is made by plotting the observed discharges on squared paper, using a horizontal scale of gauge-readings and a vertical scale of discharges, or *vice versâ*.

For the Brampford Speke gauge on the Exe I have eight measured discharges for various gauges. These I have plotted; and I have also interpolated one or two discharges by calculation, using Bazin's formula, which is less complicated than Kutter's, and which is reliable except for very flat surface-slopes such as we have on the Medway. I have marked on the curve the actual positions of the eight measured discharges, and six of the eight lie exactly on the curve, while two discharges lie outside the curve. These two abnormal discharges are very instructive.

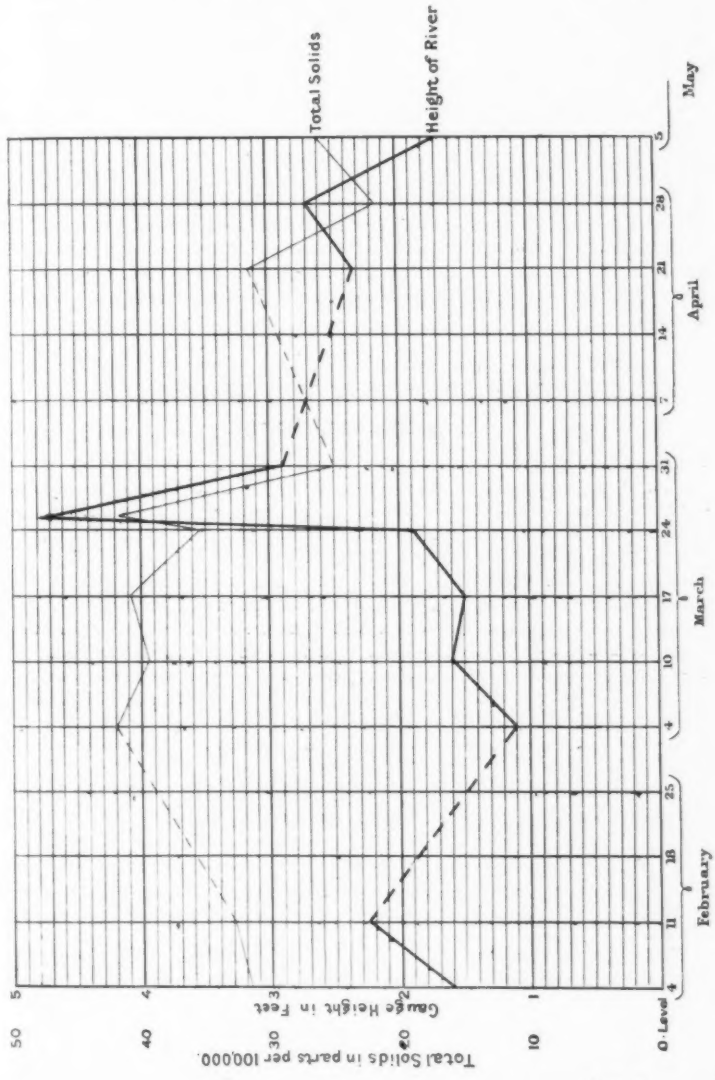
The lower discharge was for a gauge of 1 foot $6\frac{3}{4}$ inches, and gives a volume of 363 cusecs. On looking up the records, I find the observer (Mr. Beckit) notes as follows: "In the right-hand section many small twigs of trees hung into the water, and this may have affected the floats, though this was not visibly the case." In this section the average timing of the floats over a run of 100 feet was 31·8 seconds. Assuming that the twigs did interfere with the floats, and that the timing ought to have been about 30 seconds, this adds 13 cusecs on to the discharge, making it 375 cusecs, which exactly comes on to the curve.

The second abnormal discharge was for a gauge of 2 feet. The observer (Dr. Strahan) notes that in one of the sections the floats had to be run further out from the bank than usual, as some overhanging bushes would otherwise have

interfered with them. This means that in that particular section the surface velocity, and therefore the discharge, was somewhat too great. This again coincides with what is shown by the discharge-curve.

These two abnormal discharges indicate—

1. The value of a graphic curve rather than a table of figures. The curve



shows at once where a measured discharge does not agree with the other measured discharges, and this might easily be overlooked in a table of figures.

2. The extreme importance of an observer noting any detail, however apparently trivial, which might affect his observations.

The notes by Dr. Strahan and Mr. Beckit show clearly that the curve is correct, and that their observations were affected by influences which, small in themselves, are appreciable when plotted on squared paper. But for these notes, the causes of the abnormal discharges would have remained uncertain.

In the Brampford Speke gauge-curve I have no measured discharges below an 8-inch gauge. I have calculated and dotted in pencil what the probable curve will be. Again, between 2 feet 6½ inches and 4 feet 3¾ inches there is no measured discharge, and the curve I have indicated is got by calculation. Some actually measured discharges between these limits will be useful as a check, but the whole curve fits in so well that I think it may be accepted as final. The Brampford Speke gauge is the only one on the Exe and its tributaries for which I have been able to complete a discharge-curve. For the remaining gauges at Exeter, on the Creedy, and on the Culm, we require several measured discharges before a discharge curve can be plotted. The Brampford Speke curve enables us to work out the discharge of the Exe at that point for any gauges inside the range over which it extends.

PRELIMINARY NOTE UPON THE MEDWAY BASIN.

By ERNEST W. DANN.

THE work done by me is in its incipient stages. It having been suggested during the Christmas vacation that the Medway investigation might conveniently be entrusted to one whose home lay as near to the centre of things as Reigate, the Chairman of the Committee confirmed the invitation, and I received the 6-inch quarter-sheets, geologically coloured, towards the end of January of this year. There are 121 such quarter-sheets, and so far I have endeavoured to keep in line with Mr. Elton's careful treatment of his task in connection with the river Exe. As the season was unpropitious for work upon the ground at the first, I separated the sheets containing any part of the divide from those entirely within the basin, in order to measure the latter without interruption. It was some weeks before a start could be made with the planimeter, as it had to be provided with an engine-divided scale of a special pattern. This has marked upon one edge decimal parts of 18 inches, and upon the other decimal parts of a foot, thus making corrections for shrinkage or stretching a very simple matter.

Of the twenty-four sheets measured so far, two are exact, and of the rest, fifteen have stretched and seven shrunk, the average working out the same—0·33 per cent. of variation. The fine adjustment upon the planimeter allows of easy correction of these inaccuracies, and any slight errors found after measurement and checking of the same are, as in the case of the Exe maps, distributed proportionately. The dimensions have been found on the whole to be more accurate than one had expected.

With regard to outdoor work, some 20 miles of the divide have been carefully plotted in upon the ground, ranging from the high land north-west of Titsey, with its magnificent views of the Weald, to Crawley Down, east of Three Bridges. The work has been full of interest, as the orographical features south of the Redhill-Bletchingley Greensand ridge are so indeterminate that the distinguishing of the Mole *régime* from that of the Medway requires very close attention to every fold of

the ground. Near Smallfield Place (due east of Horley) a ridge of less than 15 feet in height marks the divide. I usually find my way to the spot for investigation by sketching the watershed upon the 1-inch sheet. Taking the necessary 6-inch maps to the required place, I then put in the true watershed in the field. It is interesting to see how the differences in the positions of bench-marks on the two types of sheet involve discrepancies, at times, of as much as half a mile. I hope to devote the major part of the long days of the summer-vacation to this work, and one can reasonably expect that the whole of the 680 square miles or so of area will be accurately determined by the middle of September.

Speaking generally, it will be necessary slightly to extend the geological colouring in a number of the sheets supplied, and two more are needed to complete the basin. It will be remembered that by far the greater part of the flow is longitudinal. From the sources of the Beult to that of the Eden and Medway is about 48 miles, and the distance from Frith Wood (near Ticehurst) to Allington lock is less than 15. The slope is very slight, and the underlying formations are for the most part impermeab

REPORT ON EXAMINATION OF SEVERN WATER, WORCESTER, 1909.

By GEORGE H. WOOLLATT, Ph.D., F.I.C., and C. W. MARSHALL.

EXAMINATION of river-water for total solids and for solids in suspension was undertaken during 1909 at the request of Dr. Strahan.

Arrangements were made to take weekly samples of the river-water from the neighbourhood of the waterworks-intake, where a projecting "fend" runs out into the stream. Owing, however, to difficulty in securing good samples in different conditions of the stream, this was abandoned, and a boat taken out into the centre of the stream in each case, thus securing comparable samples in all states of the stream.

The water was collected by immersing a large bottle suddenly to a depth of 6 inches below the surface, in order to avoid any deposition of suspended matter that might occur if pipes or pumps were used. The height of the stream was read from the waterworks-gauge, within one minute of collecting the sample. Usually two litres of water were sufficient, the weighings being taken to four decimal places (the fifth estimated where necessary), and "blanks" to check the weighings being carried out frequently.

Arrangements were made at the waterworks, that any rise or fall approaching 12 inches should be at once communicated to me. In one case this happened, and a sample was immediately collected and examined (see VII., Mar. 26).

It was noticed that the rapidity of the stream was not proportional to its height on the gauge; also that the colour of the water (and consequently the amount of suspended matter) was not proportional to the height of river. It would appear that the "total solids" increases on a falling river, and decreases on a rising river (see comparative graph accompanying). There does not appear to be any simple relation connecting these variables, nor is it possible to trace any between the pace of the stream and its height. Frequently, also, the muddiness of the river varies at constant height.

Below is a table of results obtained up to the beginning of May.

It has not been found practicable to divide the suspended solids into organic and inorganic portions, owing mainly to the small quantity of residues obtained; but a special investigation of the settlings of the suspended matter, over a period of three

weeks, gave a mixture containing 25·31 per cent. organic and 74·69 per cent. inorganic matter. This may be considered about the average. In autumn the organic matter will be greater, and the matter will be similarly investigated then. It is also intended to pursue some investigations into the question of a possible difference in total solids at various depths below surface.

TABLE OF RESULTS.

Note.—All the samples quoted below were taken—
(1) From the centre of stream.
(2) From a depth of 6 inches below surface.

No.	Date.	Time.	Height on gauge.	Condition of stream.*	Solids in parts per 100,000.		
					Suspended.	Dissolved.	Total.
I.	Feb. 4, 1909	3.30 p.m.	1′ 7″	moderate clear	0·40	31·2	31·60
II.	Feb. 2, ,,	3.15 ,,	2′ 4″	rapid	0·43	32·4	32·83
III.	Mar. 4, ,,	3.15 ,,	1′ 1″	sluggish	0·39	41·6	41·99
IV.	Mar. 10, ,,	4.0 ,,	1′ 7″	slow	3·24	36·4	39·64
V.	Mar. 17, ,,	3.20 ,,	1′ 6″	slow	0·83	40·8	41·63
VI.	Mar. 24, ,,	3.16 ,,	1′ 10″	moderate	5·14	30·2	35·34
VII.	Mar. 26, ,,	3.0 ,,	4′ 9½″	very rapid rough	19·76	22·0	41·76
VIII.	Mar. 31, ,,	3.15 ,,	2′ 10″	rapid	2·40	22·6	25·00
IX.	Apr. 21, ,,	3.15 ,,	2′ 4″	rapid	3·20	28·2	31·40
X.	Apr. 28, ,,	3.15 ,,	2′ 8″	rapid	1·77	20·2	21·97
XI.	May 5, ,,	3.15 ,,	1′ 8″	moderate	2·00	24·0	26·00

REPORT ON THE RAINFALL OF THE EXE VALLEY

By HUGH ROBERT MILL, D.Sc.

THE problem of ascertaining the average quantity of precipitation which falls upon a given area in a long series of years, resolves itself into the construction of a rainfall map from the records of irregularly distributed stations, continued for a variable number of years and of different degrees of accuracy. The accuracy of the observations depends on the use of proper instruments suitably exposed and regularly examined. In most cases it is easy to detect gross errors, such as an annual total which is more than 10 inches too high or too low, and returns which are clearly erroneous are excluded from the annual volumes of 'British Rainfall,' the source from which practically all the data used have been obtained. Errors of smaller amount, though often suspected, are not always demonstrated before the publication of the annual volume, and the only practicable test is the

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* The pace of the stream is difficult to measure accurately, owing to bends in the river, and eddy-currents. The words used above are intended to be roughly proportional to the following numbers:—

sluggish	1	in miles per hour.
slow	2	
moderate	3	
rapid	4	
very rapid	5	

general congruence of the whole series of figures for a particular year when placed on a map.

It need not be insisted upon that one of the main objects in using the average of a long series of years is that accidental errors may either be eliminated or so reduced as not to affect the final result seriously. In favourable circumstances, it is possible to compute the long-period average of short records, by comparing them with the corresponding portions of neighbouring records running through the whole period chosen for the average, and this is the method usually adopted; but it can only be done when at least one complete record exists for each of the natural regions of the area, as it is rare to find uniform differences from the average prevailing over any large extent of country in any one year.

The number of long records in the Exe valley or on its borders is not sufficient to justify the use of this method, which was successfully employed in constructing the maps of average rainfall prepared for the Water Supply Memoirs of the Geological Survey for districts where long records are more numerous. It was therefore found necessary to construct a series of short-period maps which could be subsequently combined to yield a map of average rainfall for a much longer period. It was convenient to use ten years for the short-period means, and possible to utilize four decades of observations. The operations included (1) Testing the available data; (2) compiling maps for four successive periods of ten years each; (3) combining the four into one average map for forty years; (4) computing the general average rainfall of the various tributary streams and of the whole valley; (5) discussing the distribution of annual rainfall in space and time.

The number of stations for the observation of rainfall before 1868 was so small, that it was found impracticable to carry the discussion further back than that year; but a map was constructed for each of the decades, 1868–1877, 1878–1887, 1888–1897, 1898–1907, from data which are summarized in the accompanying tables. As this method of procedure has not been used before as far as I know, it may be desirable to describe it in some detail. In mapping the 2500 square miles of country including and surrounding the valley of the Exe, 173 separate rainfall-records were dealt with, the duration ranging from 1 to 40 years as follows:—

Years' duration ...	1–4	5–9	10–14	15–19	20–24	25–29	30–34	35–40	Total.
No. of records ...	49	37	38	14	14	6	6	9	173

The total number of yearly values was 2101, and on the very moderate computation of 200 rain-days in the year, this represents about 420,000 separate readings of the rain-gauge. Very many of the records would have been lost—and a large number would never have started—but for the constant watchfulness of the successive editors of 'British Rainfall,' and the continuous efforts made to secure accurate observations and careful records. Practically, the whole of the observations were carried out by voluntary amateur observers.

The first step in the case of each ten-yearly period was to write out the total annual rainfall for all the stations comprised in the Exe valley and the surrounding country, the whole area dealt with being a stretch of 52 miles by 48, and the Ordnance map on the scale of 4 miles to 1 inch was chosen for plotting the results. In each period, the records were complete for ten years at a number of stations, and the ten-year means of these expressed to the nearest half-inch were placed upon the map. At a number of stations means of less than ten years were available, and as these means might refer to a period either wetter or drier than the mean of ten years, it would obviously be misleading to place them on the map without correction. The most convenient mode of correction is to apply to the mean of, say, five years the ratio which the same five years of a complete decade bears to the whole, using for

this purpose the mean ratio for the period at several contiguous stations with complete records. For example, if at a particular station five years' records gave a mean of 40 inches, and at three neighbouring stations with complete records, the ratios of the mean rainfall of that period of five years to the whole ten-year period were respectively 85, 87, and 83 per cent., the mean ratio would be 85 per cent., and the 40 inches would have to be increased in the ratio of 85 to 100, *i.e.* to 47 inches, in order to represent the computed average for ten years. The figures in Table I thus yielded actual or computed averages which were scattered over the four ten-year maps somewhat irregularly, and as the individual stations represented were not always the same in successive periods, a further calculation was made by which the rainfall for each station occurring in any decade could be represented on the map of another decade by a computed value. To arrive at this result, a series of percentages was worked for all the stations represented on two or more maps falling into six groups, thus—

(1)	Rainfall	on	Map I	expressed	as percentage of rainfall	on Map II.
(2)	,,		I	,,	,, ,,	III.
(3)	,,		I	,,	,, ,,	IV.
(4)	,,		II	,,	,, ,,	III.
(5)	,,		II	,,	,, ,,	IV.
(6)	,,		III	,,	,, ,,	IV.

All the percentages of group (1) were plotted on a map, and it was found that, as a rule, the values varied regularly from one part of the area to the other. Values that were very discordant with those around them were disregarded, and the percentage which corresponded to a point on Map I where there was no figure on that map, but where a figure occurred on Map II, could be read off by inspection. The value on Map II (decade 1868–1877), reduced or increased in the ratio of the particular percentage to 100, was then placed as a computed mean on Map I (decade 1878–1887). It might be that these computed values were obtained for the same point from several different decades, and when this was so, a mean was taken. This process, worked out for each of the groups, supplied a number of supplementary points on each map, which, though less trustworthy than the points for which direct values were available, might yet supply useful indications of the direction of the isohyetal lines. At best the distribution was irregular, and observations were most deficient in the valley of the Creedy and the whole district between Dartmoor and Exmoor west of the main river Exe, where consequently the run of the isohyets is less decided than in other parts of the region.

It was obvious on each of the maps that the distribution of average annual rainfall was governed by the configuration of the country taken in conjunction with the direction of the prevailing wind. The estuary of the Exe was always the driest portion; Dartmoor and Exmoor were two dominating centres of high rainfall, and a third centre of moderately high rainfall occurred on the hills of eastern Devon. The four maps (which are reproduced on a small scale) were so closely similar in the run of the isohyets that there could be no doubt as to the general character of the distribution of rainfall, and by extending the area far beyond the Exe valley on every side, it was possible to draw the lines across the valley with far more confidence than if attention had been strictly confined to the actual area the hydrographical conditions of which were under discussion.

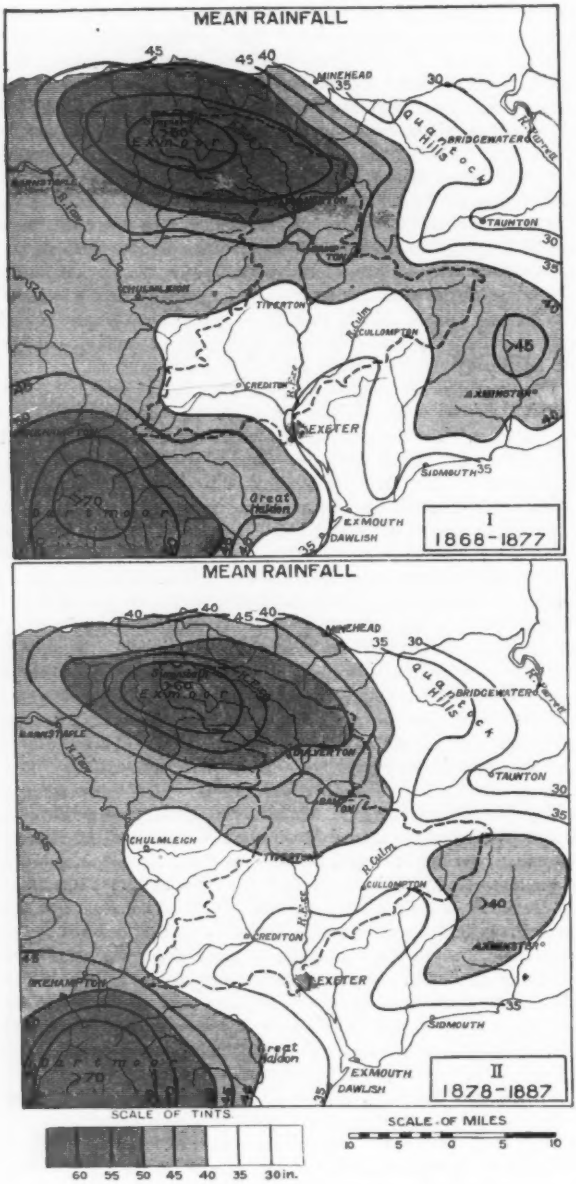
The combination of the four maps of ten-year means into one map of forty years' average presented several points of difficulty. Two entirely different methods were employed with a satisfactory degree of accordance. The first method consisted of tracing off an isohyet of a given value separately from two of the maps

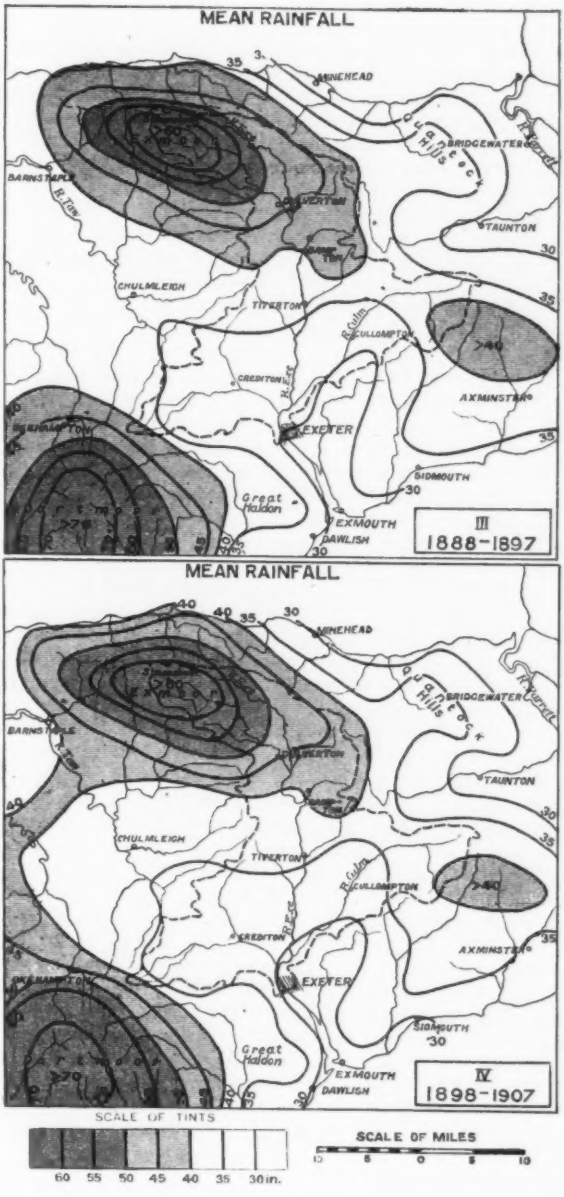
and drawing the mean curve between them, repeating this for the other two maps on the same piece of tracing-paper, and then drawing the mean of the two mean isohyets, which, of course, corresponded to the forty years' average. This method was found to act perfectly for all the isohyets at intervals of 5 inches above 40 inches, as these occur on all the maps, but it was somewhat at fault for those of 30 and 35 inches, which occur only on some maps, and quite ineffective for the line of 40 inches, which on one occasion formed a single curve surrounding the dry central area, on two occasions a curve surrounding the dry area only on the west and north, and on the fourth a set of separate curves surrounding the various wet areas. The method could only be fully satisfactory if the periods compared were long enough to reduce the differences to so small an amount that all the isohyets of the same name were similar in form on the several maps. The method might indeed be employed to deduce an average map from a very large number of separate annual maps by a process akin to making composite photographs of each isohyet line in all the maps, the average position of the isohyet standing out as the result of all the impressions; but the number of individual maps would require to be very great in order to eliminate the disturbing effect of extreme cases.

The other method used consisted in ruling up each map into a network of numbered squares. The number actually used was 19 equidistant vertical lines crossed by 17 equidistant horizontal lines; and of the 323 intersections thus made, 294 fell on the land. The closest approximation to the value of the rainfall at each intersection which could be arrived at by inspection of the isohyetal lines and actual figures was written down, and the means of the values at each intersection on the four maps were used to construct an average map from 294 equidistant points, upon which a fresh set of isohyets was drawn. The map thus produced corresponded so closely with the map made by compounding the isohyets (except in the case of the line of 40 inches), that both systems must be viewed as yielding identical results for the wetter part of the area; but in the drier parts the mean of the intersections of course gave definite isohyets in places where the dissimilar forms of the lines made it impossible to arrive at them by the first method, and I have no hesitation in accepting the map constructed from the 294 points as the closest approximation to the actual distribution of rainfall which the data can yield, and the map is accordingly reproduced here and used in the following discussion.

Adopting the map of average rainfall 1868–1907, prepared by the second method, as representing the normal distribution of rain over the Exe valley and its surroundings, we are in a position to discuss the relation of precipitation to the configuration. As was to be expected, the heaviest rainfall occurs on Dartmoor, where a wide area round Princetown has certainly more than 70 inches per annum. So far as can be judged, the wettest part of Dartmoor lies to the south of the highest point; but the absence of records on the northern slope of the moor makes the exact position of the higher isohyets somewhat uncertain. The rainfall diminishes rapidly in all directions, and the extreme western point of the Creedy valley just touches the 45-inch line. The diminution of rainfall is least rapid towards the east, but this is seen chiefly in the wide sweep of the isohyets of 40 and 35 inches towards the Great Haldon ridge south of Exeter.

The hills of East Devon between Honiton, Axminster, and Chard precipitate a relatively high rainfall, the isohyet of 40 inches including a large area which stretches into the eastern end of the Culm valley, and may possibly be found by additional observations to extend as a narrow neck to the wet area of Exmoor. Probably rainfalls as high as 45 inches will be found near Stockland, but the data do not permit of this being shown on the map. It appears that the very wet area


MEAN RAINFALL
MINEHEAD
BRIDGEWATER
TAUNTON
TIVERTON
CULLOMPTON
CREDITON
EXETER
SIDMOUTH
EXMOUTH
DAWLISH
I
1868-1877
MEAN RAINFALL
II
1878-1887
SCALE OF TINTS.
60 55 50 45 40 35 30in.
SCALE OF MILES.
10 5 0 5 10


MEAN RAINFALL
MINEHEAD
BRIDGEWATER
TAUNTON
BARNSTAPLE
CHULMLEIGH
TIVERTON
CULLOMPTON
CREDITON
AXMINSTER
EXETER
SIDMOUTH
EXMOUTH
DAWLISH
Great Haldon
III
1888-1897
MEAN RAINFALL
IV
1898-1907
SCALE OF TINTS
60 55 50 45 40 35 30 in.
SCALE OF MILES
0 5 0 5 10

on Dartmoor is elliptical in outline, with the long axis directed north and south; the smaller and less marked wet patch in the east is roughly circular in outline, and both of these lie practically outside the valley of the Exe so far as their influence on the volume of water reaching the river is concerned.

The third wet region dominates the Exe valley, and stretches in a long ellipse with the longer axis directed from west-north-west to east-south-east over Exmoor. The isohyet of 40 inches probably just reaches the northern corner of the Culm valley, crosses the Exe valley in an east-and-west direction midway between Tiverton and Bampton, and, sweeping far to the west, returns along the northern slope of Dartmoor to cross the south-western extremity of the Creedy valley. So far as the excellent, though rather scanty, records on Exmoor show, the wettest portion has somewhat more than 65 inches over about 8 square miles surrounding the source of the Burle, and the rainfall diminishes as the valley widens at the rate of about 5 inches in 3 miles for 12 miles down-stream, and then much more slowly. The Exe valley below Tiverton, and the whole valleys of the Culm and Creedy, belong to the central area of moderate rainfall, averaging about 37 inches, and sheltered from all winds except those from north-west, south-east, and north-east by land that is substantially higher; but the drainage from one only out of the three intercepting high land-masses finds its way into the Exe. This fact considerably simplifies the *régime* of the river, which is dependent mainly on the heavy rains of Exmoor so far as its average flow is concerned.

The calculation of the total volume of water which falls as rain in an average year can be made from the average map in two separate ways. For convenience in dealing with two sets of mean values it is well to have two words to avoid confusion, and I have found it useful to use the word "average" for the mean of a long series of yearly values, and "general" for the mean at a large number of points uniformly distributed over a surface. Thus the general rainfall of the valley of the Exe is the mean depth at which the rain of a given period would stand, supposing it to remain as it fell without running off, evaporating, or percolating into the soil. The average general rainfall is the mean general rainfall for a long series of years. If the number of points from which an average rainfall map is constructed be sufficiently great, and sufficiently uniformly distributed, the mean of them all would give the average general rainfall of the area represented in the map. It usually happens, however, that a map has to be constructed, like those of the four decades for the Exe valley, from irregularly distributed points, the mean of which might be a totally misleading figure if used to represent the general rainfall. In such a case the general rainfall may be best obtained by measuring the areas between successive isohyets, multiplying each area by the general rainfall of the zone, which is either the mean of the two isohyets or some figure not greatly differing from the mean which can readily be obtained by inspection, adding all those volumes together, and dividing by the total area. In the case of the average map of the Exe valley the calculation has been made in both ways, utilizing the points from which the map was constructed for the simple arithmetical computation, and measuring the areas between the lines with a planimeter on the quarter-inch map for the computation by zones.

The comparison of the two methods is shown in the following tables for each of the tributary basins and for the whole valley above Exeter, the terminal points of each basin being taken at the position where the river-gauges are fixed, so that a comparison with the stream-flow can be made when required:—

TABLE I.

Rainfall in the Neighbourhood of the River Exe.

Station.	Height above sea-level.	Duration of record.			Rainfall.				
		First year.	Last year.	No. of years.	Arithmetical mean.	Means for decades.*			
						I.	II.	III.	IV.
	feet.				ins.	ins.	ins.	ins.	ins.
Teignmouth, Woodway	235	1879	1890	12	33·59	—	34·80	30·90	—
,, Bonnicliff	260	1890	1907	18	31·46	—	—	31·60	31·24
Dawlish, Great Oak Park ...	120	1876	1889	14	35·78	36·90	35·66	31·20	—
Chudleigh, Ideford	300	1887	1907	21	33·87	—	36·10	34·34	34·44
Islington, Middlecott House ...	649	1868	1897	30	47·86	48·60	51·30	46·50	—†
Bovey Tracey, Colehays ...	415	1886	1907	21	44·56	—	48·90	44·90	46·40
,, ",.	93	1868	1884	17	45·93	46·26	43·40	—	—
Princetown	1360	{1880 1886 1893 1896	{1881 1889 1894 1907}	20	76·55	—	76·20	76·90	78·33
,, Cowsic valley ...	1352	1880	1907	28	72·37	—	78·10	73·74	68·26
Exmouth, Nidderdale	51	1893	1907	15	27·72	—	—	28·50	27·21
,, Mamhead	467	1892	1904	13	38·52	—	—	38·40	38·00
Torquay Water Works, Trusham	322	1885	1907	23	36·71	—	40·10	37·42	36·29
,, ,, ,, Tottiford	718	1881	1904	24	41·13	—	43·50	42·40	40·20†
,, ,, ,, Bullaton	928	1906	1908	3	37·77	—	—	—	42·30
,, ,, ,, Mardon	835	1904	1907	4	37·58	—	—	—	39·70
,, ,, ,, Kennick	842	1890	1907	18	40·38	—	—	40·97	39·62
Moretonhampstead	600	1902	1907	6	42·12	—	—	—	41·60
Chagford, Frenchbeare	950	1907	1908	2	52·50	—	—	—	56·60
,, Batworthy	1250	1885	1896	12	59·42	—	65·90	60·46	—
,, Dartmoor Sanatorium	750	1905	1908	4	43·24	—	—	—	47·80
Budleigh Salterton, Ravenshaw	50	{1887 1901}	{1898 1902}	14	28·55	—	30·70	29·86	29·20
,, ,,	80	1868	1890	23	32·34	35·40	32·70	29·60	—†
Kenton, Southtown House ...	56	1890	1907	18	33·36	—	—	33·50	34·00†
Powderham Castle	57	1875	1887	13	35·39	37·30	33·90	—	—†
Kenn, Chapel Court	126	1908	1908	1	25·52	—	—	—	33·70†
East Budleigh	70	1874	1890	16	33·78	35·40	33·81	30·60	—
,, ,, Bicton	90	1889	1907	19	29·76	—	—	30·20	29·63
Sidmouth, Sidmount	149	1870	1907	38	32·01	32·70	33·52	31·17	30·18
Topsham, Clyst St. George ...	76	1868	1884	17	33·65	33·73	32·60	—	—
Exeter, Ide	90	1907	1907	1	34·61	—	—	—	36·10
Seaton, White Cliff Glen ...	125	1871	1881	11	38·27	37·00	36·20	—	—†
Lyme Regis, Clevelands ...	465	1870	1907	38	35·18	37·35	36·44	34·48	32·42
Aylesbeare, Rosamondford ...	220	1904	1908	5	29·09	—	—	—	31·60
Exeter, St. Thomas	65	1902	1907	6	32·73	—	—	—	33·10
,, Manston terrace ...	165	1868	1904	37	32·06	35·84	32·20	29·11	29·20
,, Heavitree	175	1899	1906	8	31·51	—	—	—	30·80
,, St. Leonard's road ...	110	{1883– 1886}	{1884 1889}	6	29·80	—	32·80	31·60	—
,, Lyndhurst road	140	1891	1894	4	31·25	—	—	30·60	—
,, D. & E. Institution ...	155	1868	1907	40	31·55	34·80	32·30	29·48	29·63
,, Elmfield	100	1899	1907	9	28·22	—	—	—	28·60†
Cheriton Bishop	575	1907	1908	2	29·62	—	—	—	32·40
Okehampton, Oaklands	500	1870	1907	38	46·95	50·29	47·66	45·10	44·85
Spreyton	735	1903	1908	4	33·82	—	—	—	34·10
Broad Clyst, Brockhill ...	80	{1878 1882}	{1879 1907}	28	29·38	—	31·00	29·10	28·41
Newton St. Cyres	145	1904	1908	5	28·43	—	—	—	31·50
Upton Pyne	213	1903	1907	5	33·23	—	—	—	33·10
Brampford Speke	140	1868	1891	24	35·19	36·91	34·51	31·70	—
Crediton, Newcombes	251	1904	1906	3	32·02	—	—	—	34·40
,, Okefield	325	1905	1908	4	28·04	—	—	—	32·50
Silverton, Killerton	161	1904	1907	4	27·10	—	—	—	28·50†
Kilmington, Haddon Corner ...	400	1904	1908	5	34·36	—	—	—	35·50
Axminster	138	1882	1893	12	35·24	—	39·00	35·50	—†
Honiton, Gittisham	—	1868	1883	16	41·16	40 84	39·30	—	—
,, Feniton court	229	1889	1892	4	32·51	—	—	33·90	—
,, St. Cyrus	—	1907	1907	1	36·51	—	—	—	35·90
,, Ivedon	430	1889	1900	12	32·59	—	—	33·69	31·80
,, Combe Raleigh ...	500	1902	1907	6	36·90	—	—	—	36·60†
Hatherleigh, Broomford Manor	484	1882	1897	16	40·94	—	43·00	39·67	—
Zeal Monachorum	600	1870	1879	10	41·63	41·11	40·90	—	—
Stockleigh Pomeroy	340	1895	1907	13	32·84	—	—	32·20	33·01

* Decade I. = 1868–1877; II. = 1878–1887; III. = 1888–1897; IV. = 1898–1907.

† A slight correction has been applied at this station, on account of the height of the rain-gauge above ground considerably exceeding 1 foot.

Station.	Height above sea-level.	Duration of record.			Rainfall.				
		First year.	Last year.	No. of years.	Arithmetical mean.	Means for decades.*			
						I.	II.	III.	IV.
	feet.				ins.	ins.	ins.	ins.	ins.
Clyst Hydon	200	1868	1880	13	33·97	34·47	31·70	—	—
Bradninch, Strath Culm	159	1868	1882	15	33·91	33·93	31·80	—	—
,, ...	250	1868	1873	6	35·08	38·00	—	—	—
,, Vicarage	316	1877	1887	11	37·07	41·10	36·26	—	—
Broadhembury	400	1868	1873	6	33·68	35·50	—	—	—
Chard, Tatworth	347	1902	1907	6	41·94	—	—	—	40·40
,, Cricket St. Thomas ...	403	1868	1907	40	39·72	44·15	39·59	38·59	36·54
Cullompton	202	1881	1907	27	34·29	—	36·24	33·72	33·72
Dunkerswell Abbey	800	1907	1908	2	35·42	—	—	—	39·10
Heanton Satchville	332	1885	1907	23	37·98	—	42·80	37·89	37·77
Dolton, Hilliers	380	1907	1908	2	33·44	—	—	—	36·70
Chulmleigh, Eggesford	400	1871	1877	7	42·21	40·20	—	—	—
Witheridge	600	1891	1894	4	39·77	—	—	38·30	—
Tiverton, Rose Bank	280	1876	1887	12	41·33	39·50	42·29	—	—
,, Highfield	450	1903	1907	5	41·60	—	—	—	40·60
,, Broomhill	380	1883 1897	1894 1907	23	36·96	—	41·00	37·30	35·54
,, Ivy Place St. Peter's Street	270	1880	1907	28	36·56	—	40·90	37·70	37·40†
,, Exe Villa	230	1873	1878	6	42·95	39·80	39·40	—	—
,, Springfield	300	1868	1875	8	41·13	43·00	—	—	—
Halberton	240	1906	1908	3	31·47	—	—	—	34·00
Uffculme, Bullmoor	280	1902	1907	6	34·21	—	—	—	34·20
Tiverton, Chevithorne	510	1872	1873	2	47·56	40·50	—	—	—
Loxbear	—	1874	1874	1	34·76	34·20	—	—	—
Otterford, Otterhead	735	1894	1903	10	39·17	—	—	37·50	37·60
Churchstanton	800	1882	1884	2	41·75	—	39·50	—	—
Blagdon Hill reservoir	588	1894	1907	14	35·78	—	—	33·90	35·89
Leigh Hill reservoir	525	1894	1907	14	34·45	—	—	33·00	34·42
,, Court	350	1902	1907	6	34·04	—	—	—	33·30
Torrington, Little Silver ...	400	1877 1892	1890 1907	30	41·18	42·70	43·82	38·98	40·06
,, Stevenstone ...	420	1880	1907	28	41·13	—	43·50	39·65	41·03
Rackenford, Cruwysbaye ...	400	1894	1894	1	46·65	—	—	40·60	—
Meshaw	472	1868	1877	10	41·99	41·99	—	—	—
Romansleigh	590	1900	1906	7	37·89	—	—	—	37·10
Rose Ash	650	1870	1894	25	40·55	43·24	39·28	38·30	—
Bampton, Cove	450	1868	1887	20	42·90	44·41	41·40	—	—
Huntsham Court	640	1874	1907	34	45·21	47·30	45·62	44·66	42·45
Wellington, The Avenue ...	254	1893	1906	14	30·85	—	—	30·30	30·40
,, Windwhistle House	300	1894	1896	3	32·90	—	—	31·70	—
,, Sunnyside	—	1880 1890	1887 1894	12	32·41	—	32·20	32·90	—
Bampton, Wonham	530	1898	1907	10	39·23	—	—	—	39·23
,, ...	400	1868	1871	4	39·46	45·70	—	—	—
Exebridge	400	1908	1908	1	35·68	—	—	—	42·60
Chittlehamholt	500	1903	1904	2	44·43	—	—	—	38·20
Taunton, Gatchell House ...	160	1907	1907	1	29·88	—	—	—	28·90
,, Claremont	80	1891	1901	11	27·34	—	—	27·20	26·50
,, Linden Grove	70	1900	1907	8	27·59	—	—	—	27·30
,, Ashleigh	78	1900	1907	8	26·82	—	—	—	26·60
,, ...	80	1893	1894	2	28·26	—	—	26·40	—
,, Fullands School ...	—	1868	1883	16	29·63	29·40	28·20	—	—
Milverton, Olands	330	1903	1906	4	34·79	—	—	—	34·20
,, The Nook	265	1898	1904	7	33·49	—	—	—	32·00
,, The Lodge	198	1880	1897	18	34·66	—	37·36	33·33	—
,, Spring Grove ...	500	1897	1907	11	35·40	—	—	34·30	35·04
Taunton, Staplegrove	108	1902	1905	4	30·59	—	—	—	29·60
Norton FitzWarren	140	1888	1894	7	31·59	—	—	32·00	—
Wiveliscombe, Wythycombe House	800	1878	1883	6	42·30	—	39·60	—	—
Wiveliscombe	—	1868	1881	14	36·27	36·75	34·30	—	—
Halse, The Mount	254	1894 1906	1903 1907	12	33·64	—	—	32·80	32·10
,, Rectory	245	1877	1882	6	36·33	34·30	33·30	—	—
,, ...	200	1884	1891	8	30·20	—	33·50	30·40	—
Fitzhead	297	1880 1886	1884 1890	10	34·31	—	37·00	33·10	—
South Molton, East Street ...	430	1874	1902	29	43·44	45·60	44·32	42·54	40·30
,, ,, ...	450	1903	1907	5	46·43	—	—	—	44·90

* Decade I. = 1868–1877; II. = 1878–1887; III. = 1888–1897; IV. = 1898–1907.

† A slight correction has been applied at this station, on account of the height of the rain-gauge above ground considerably exceeding 1 foot.

Station.	Height above sea-level.	Duration of record.			Rainfall.				
		First year.	Last year.	No. of years.	Arithmetical mean.	Means for decades.* I.	II.	III.	IV.
	feet.				ins.	ins.	ins.	ins.	ins.
South Molton	515	1894	1900	7	43·66	—	—	44·10	41·50
,, ,, Castle Hill school	363	1890	1907	18	42·35	—	—	42·10	42·27
,, ,, ,, gardens	317	{1868 / 1899}	{1893 / 1907}	35	44·24	49·00	45·00	43·50	43·40†
East Anstey	740	1906	1908	3	42·85	—	—	—	45·80
Skilgate	750	1876	1882	7	51·13	46·60	46·10	—	—
Molland	674	1906	1908	3	49·11	—	—	—	52·60
West Buckland Rectory... ...	—	1889	1889	1	40·60	—	—	44·50	—
,, ,, County school	650	1884	1888	5	43·86	—	48·10	44·60	—
Barnstaple	31	1868	1907	40	38·10	42·05	41·26	33·14	35·94
Winsford	630	1897	1907	11	50·30	—	—	47·40	49·91
Cothelstone House	500	1875	1907	33	35·49	37·00	36·12	35·91	32·29
North Petherton	122	1899	1907	9	29·82	—	—	—	29·50
Enmore Park	268	1895	1901	7	31·45	—	—	33·00	30·30
Bridgwater	30	1888	1907	20	27·79	—	—	28·28	27·31
Stoke Rivers	767	1906	1908	3	44·02	—	—	—	44·70
Bratton Fleming	—	1898	1898	1	48·83	—	—	—	52·60
Exford Rectory	905	1875	1890	16	54·10	56·80	54·25	47·10	—
,, North Ley	1000	1904	1907	4	42·57	—	—	—	46·90†
Simonsbath	1080	1899	1907	7	69·07	—	—	—	66·50
Challacombe	825	1901	1907	7	63·86	—	—	—	63·40
Arlington Court	613	1871	1907	37	54·08	55·15	53·68	51·02	54·24
Williton, Aller farm ...	190	1904	1907	3	30·31	—	—	—	33·80†
Holford, Woodlands House ...	391	1895	1907	13	32·83	—	—	33·60	32·70
Watchett, Old Cleeve	200	1885	1885	1	38·15	—	39·90	—	—
Quantockshead, St. Audries ...	250	1898	1907	10	28·04	—	—	—	28·04
Pawlett	45	1895	1904	10	28·28	—	—	29·00	27·70
Stockland Bristol	65	1898	1907	10	27·95	—	—	—	27·95
Dunster, Knowle	267	1889	1895	7	35·10	—	—	35·00	—
,, The Priory	150	1874	1881	8	36·94	37·10	32·70	—	—
,, Alcombe	85	1901	1906	6	29·28	—	—	—	29·40
Minehead, Blair	75	1889	1891	3	28·89	—	—	29·40	—
,, ...	50	1895	1899	5	31·02	—	—	30·60	32·90
,, Mariansleigh ...	45	1905	1908	4	27·39	—	—	—	30·30
Parracombe	795	1888	1907	20	47·07	—	—	46·00	50·00†
Porlock	175	1877	1883	4	52·51	50·50	48·00	—	—
Allerford, Lynch Mead	100	1907	1907	1	31·06	—	—	—	32·40
Porlock, Bossington	44	1904	1906	3	30·49	—	—	—	32·30
,, Ashley Combe	200	1884	1888	4	42·24	—	48·20	40·10	—
Lynmouth, Glenthorne	93	1874	1900	27	45·16	49·40	45·78	41·47	46·10
Martinhoe	808	{1874 / 1898}	{1878 / 1907}	14	46·73	52·60	44·00	—	44·90†
Lynton, Lee Abbey	320	1878	1907	34	38·10	43·70	37·97	35·18	38·05
,, Gwynallt	284	1894	1907	10	43·01	—	—	—	43·01
Lynmouth, Rock House ...	20	1898	1907	10	39·95	—	—	—	39·95
Burnham	18	1868	1880	13	30·26	29·80	—	—	—

TABLE II.—MEAN ANNUAL RAINFALL OF EXE VALLEY, 1868–1907.

River-basin.	Area sq. miles.	Map I. 10 yrs. 1868–77.	Map II. 10 yrs. 1878–87.	Map III. 10 yrs. 1888–97.	Map IV. 10 yrs. 1898–07.	Map VI. 40 yrs. 1868–1907.
		in.	in.	in.	in.	in.
Exe, below Brampford Speke	9·1	36·2	33·5	30·9	30·0	32·5
,, above ,, ,,	241·5	49·7	48·3	44·8	45·0	47·0
,, whole	250·6	49·3	47·8	44·3	44·5	46·4
Culm, below Silverton ...	6·5	34·8	34·1	32·0	30·1	32·5
,, above ,, ...	101·8	39·5	37·8	35·4	35·0	37·0
,, whole	108·3	39·2	37·6	35·2	34·7	36·7
Creedy ,, ...	102·0	39·3	36·6	33·8	33·8	36·1
Exe, above Exeter (by map)	460·9	**44·7**	**42·9**	**39·9**	**39·8**	**41·8**
,, ,, ,, (by 77 points)		44·8	43·2	39·8	40·2	42·0

* Decade I. = 1868–1877; II. = 1878–1887; III. = 1888–1897; IV. = 1898–1907.

† A slight correction has been applied at this station, on account of the height of the rain-gauge above ground considerably exceeding 1 foot.

The areas given in the table are the means of the planimeter measurements on the five maps, which were separately measured on the scale of 4 miles to an inch; they are merely convenient working figures, not to be taken as of high accuracy. Where exact measurements are required, the precise determinations of area from the large-scale maps will of course be used.

Table III compares the areas of the zones between successive isohyets in the Exe valley as a whole, *i.e.* above Exeter, for each of the decades and for the whole period of forty years.

TABLE III.—AREAS OF EXE VALLEY WITH RAINFALL OF DIFFERENT AMOUNTS IN SUCCESSIVE DECADES AND ON THE AVERAGE OF FORTY YEARS.

Period.	Below 30 ins.	30–35 inches.	35–40 inches.	40–45 inches.	45–50 inches.	50–55 inches.	55–60 inches.	Above 60 ins.	Whole Exe valley.
	sq. miles.	sq. miles.	sq. miles.	sq. miles.	sq. miles.	sq. miles.	sq. miles.	sq. miles.	sq. miles.
1868–1877	—	10·5	187·6	110·3	40·0	19·3	64·0	29·2	460·9
1878–1887	—	60·6	176·3	87·8	34·9	50·9	19·6	30·8	460·9
1888–1897	6·6	169·2	105·5	82·0	46·1	17·2	15·1	19·2	460·9
1898–1907	13·2	172·5	114·4	61·9	34·7	25·4	13·1	25·7	460·9
1868–1907	—	86·9	184·4	70·9	35·6	36·9	20·4	25·8	460·9

Both tables agree in showing a diminution of rainfall and an increase of the area with lower rainfalls from the earlier to the later decades; but before entering upon the question of the changes in rainfall with time, we should consider the average condition which must be taken as a basis for comparison.

The average rainfall of the Exe valley, as shown on the map for the forty years 1868–1907, is nowhere less than 30 inches; but 271·3 square miles have a rainfall less than 40 inches, 106·5 square miles a rainfall between 40 and 50 inches, and 83·1 square miles a rainfall greater than 50 inches; the general rainfall for the whole area being 41·8 inches, or, to use the convenient round number, 42 inches. An inch of rain over 1 square mile is equal to 14,479,000 gallons of water; hence 41·8 inches over 460·9 square miles is equal to 280,281·6 million gallons per annum, or to an average daily volume of 768 million gallons. Although this volume of water falls upon the Exe valley, the amount carried off by the river must be less by the amount evaporated or percolating through the ground below the bed of the stream. It is one of the main objects of the work of the committee to determine what that amount may be; but a common assumption is that it is something in the neighbourhood of 16 inches, and, if that be so, the annual flow of the river should be about 173,508 million gallons, and the average daily flow at Exeter about 475 million gallons, *i.e.* 19,790,000 gallons per hour, or 882 cubic feet per second. As the cross-section of the river at Exeter at mean level is 1204 square feet, it follows that the mean velocity of the stream, if the assumed evaporation is correct, would be 2640 feet, or half a mile per hour.

From Table II the proportion of the total volume of water falling on each of the three main basins can readily be calculated, and this is expressed in the convenient units of square-mile-inches in Table IV, and in the form of a percentage of the whole volume in Table V. The latter table shows that, while each of the three subordinate basins did in some decades contribute a slightly larger, and in others a slightly smaller, proportion of the whole volume of rainfall, the variation was not great, and never deviated appreciably from the proportions shown by the 40-years' average, viz. 60·4 per cent. for the Exe, 20·6 for the Culm, and 19 per cent. for the

Creedy. Speaking roughly, the Culm and Creedy receive an equal volume of rainfall over their basins, and the Exe three times as much as either, the Exe being the preponderating partner to the extent of 3 to 2.

TABLE IV.—VOLUME OF MEAN ANNUAL RAINFALL OF EXE VALLEY, 1868–1907.

River-basin.	Map I. 10 years 1868-87.	Map II. 10 years 1878-87.	Map III. 10 years 1888-97.	Map IV. 10 years 1898-07.	Map VI. 40 years 1-68-07.
	sq. mile-in.	sq. mile-in.	sq. mile-in.	sq. mile-in.	sq. mile-in.
Exe below Brampford Speke ...	330	300	280	270	290
„ above „ „ ...	12,020	11,670	10,840	10,870	11,330
„ whole	12,350	11,970	11,120	11,140	11,620
Culm below Silverton	220	220	210	200	210
„ above „	4,020	3,850	3,610	3,560	3,760
„ whole	4,240	4,070	3,820	3,760	3,970
Creedy	4,010	3,730	3,450	3,440	3,680
Exe above Exeter (by map) ...	20,600	19,770	18,390	18,340	19,270

TABLE V.—PERCENTAGE VOLUME OF MEAN ANNUAL RAINFALL OF EXE VALLEY, 1868–1907.

River-basin.	I. 1868-77.	II. 1878-87.	III. 1888-97.	IV. 1898-07.	VI. 1868-07.
Exe below Brampford Speke ...	1·6	1·5	1·5	1·5	1·5
„ above „ „ ...	58·4	59·0	59·0	59·2	58·8
„ whole	60·0	60·5	60·5	60·7	60·3
Culm below Silverton	1·1	1·1	1·1	1·1	1·1
„ above „	19·5	19·5	19·6	19·4	19·5
„ whole	20·6	20·6	20·7	20·5	20·6
Creedy	19·4	18·9	18·8	18·8	19·1
Exe above Exeter	100·0	100·0	100·0	100·0	100·0

Table VI takes the volume of the total precipitation of the average of forty years as 100, and expresses the proportional volume of rainfall of each of the three tributaries as percentages.

TABLE VI.

	I. 1868-77.	II. 1878-87.	III. 1888-97.	IV. 1898-1907.	VI. 1868-1907.
Exe	106	103	95	95	100
Culm	107	102	96	95	100
Creedy	109	101	94	94	100
Total	107	103	95	95	100

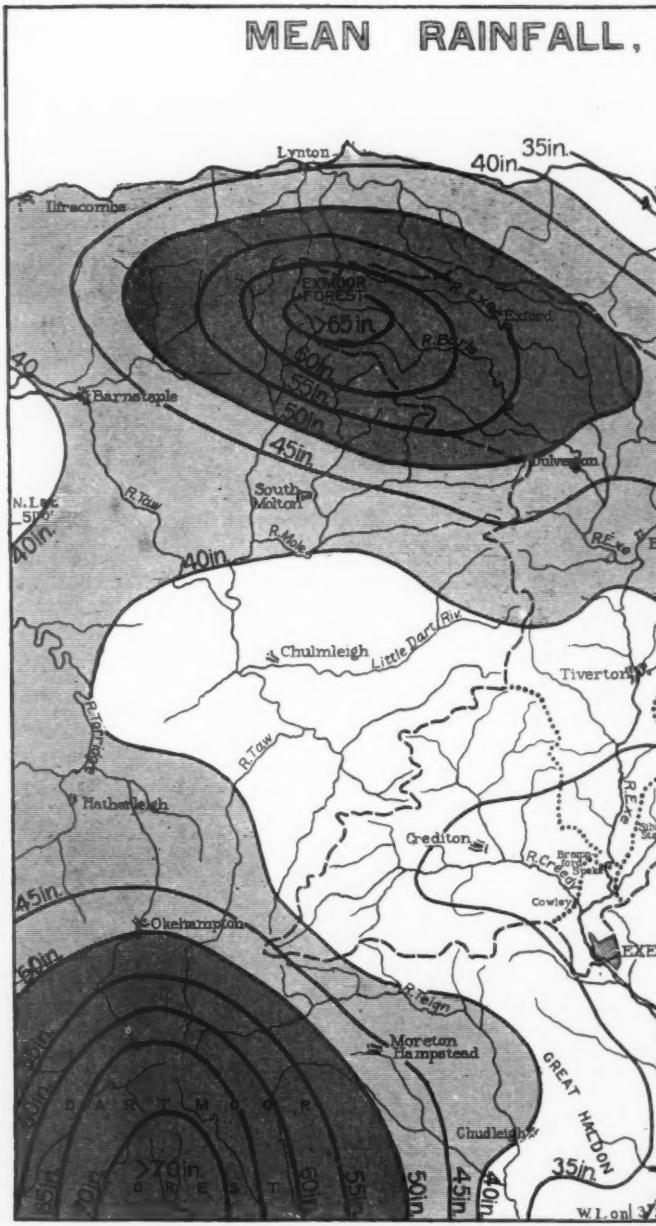
This shows that the first two decades dealt with had a general rainfall respectively 7 and 3 per cent. above the average, the last two 5 per cent. below the average, for the forty years. From the first three decades it would appear that the rainfall was steadily diminishing, but the fourth decade shows that the diminution had ceased. There is no doubt that all over the British Isles there was a spell of

very wet years in the late seventies and early eighties, and a spell of drier years in the nineties of last century, but there is no reason why another spell of wet years should not be expected to preserve the balance.

The variations from one year to another are of course much greater than the variations of the mean of consecutive decades, but in the absence of a large number of stations running through the whole period, they are not so easy to ascertain. The method we have adopted in order to overcome the deficiency of short records is as follows. There are for each of the larger tributary basins several records which run through a whole decade, and a sufficient number of these is selected to give a representative distribution. The percentage which each year's rainfall forms of the ten-year mean at that station is calculated, and the mean percentage at all the stations for each year is taken as representing the mean of the basin. This is done for each decade, and these percentages are then corrected to a common standard. This is done by taking the percentage which the general rainfall for each decade as determined from the maps makes of the average general rainfall taken from the combined map for forty years, and re-calculating the years of each decade so that, while preserving the same ratios *inter se*, they yield a mean equal, not to 100, but to the percentage greater or less than 100 which the decade forms of the general mean. All the figures then express percentages of the average general rainfall, and they are given in Table VII for each of the three divisions, and for the Exe valley as a whole. In calculating the general ratios for the valley as a whole, the ratios of the Exe above Brampford Speke have been given twice the weight of the other tributaries in accordance with the area of its valley; the rainfall calculated on the basis of an average general fall of 41·86 inches is added.

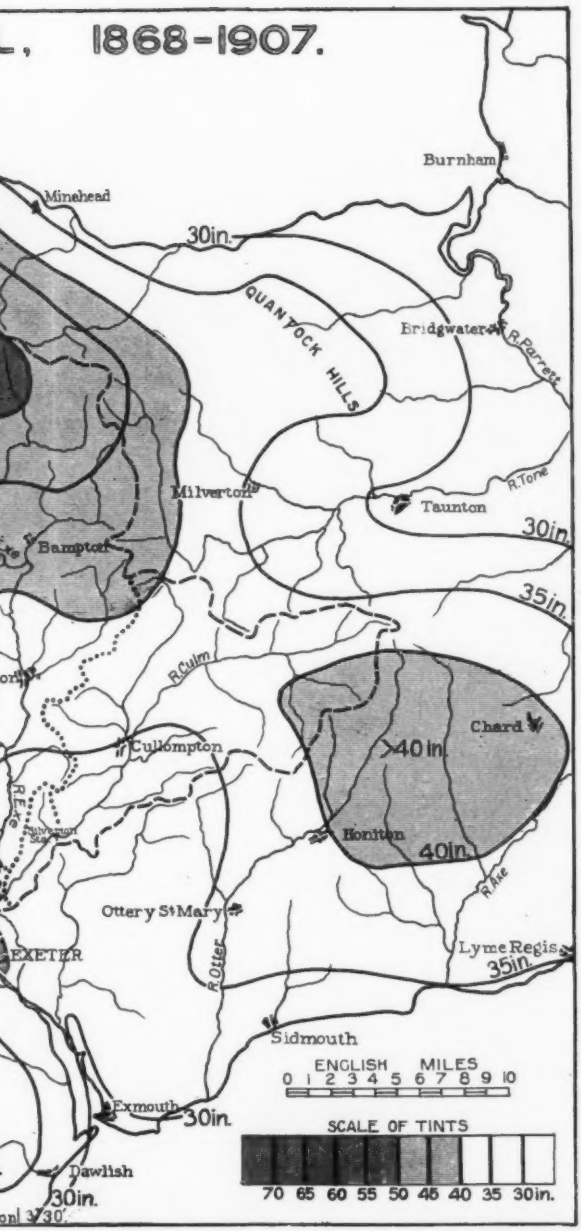
TABLE VII.—FLUCTUATION OF ANNUAL RAINFALL IN THE EXE VALLEY, 1868-1907.

Year.	Exe valley.	Culm valley.	Creedy valley.	Whole Exe valley.
1868	103	108	107	105
1869	99	94	101	98
1870	68	71	74	70
1871	94	96	101	96
1872	137	140	140	139
1873	95	94	99	96
1874	103	101	108	104
1875	120	120	120	120
1876	119	124	123	121
1877	122	120	122	121
1878	109	109	105	108
1879	102	105	103	103
1880	107	102	104	105
1881	99	103	101	101
1882	135	129	129	132
1883	105	106	106	105
1884	89	87	90	89
1885	99	103	103	101
1886	111	113	110	111
1887	73	68	68	71
1888	98	104	100	100
1889	82	81	83	82
1890	88	90	91	89
1891	112	113	109	111
1892	82	80	82	81
1893	92	89	86	90
1894	111	114	111	112
1895	98	99	97	98
1896	81	80	78	80



AVERAGE ANNUAL RAINFALL OF THE EXE VAL

II.



E VALLEY AND SURROUNDING COUNTRY.

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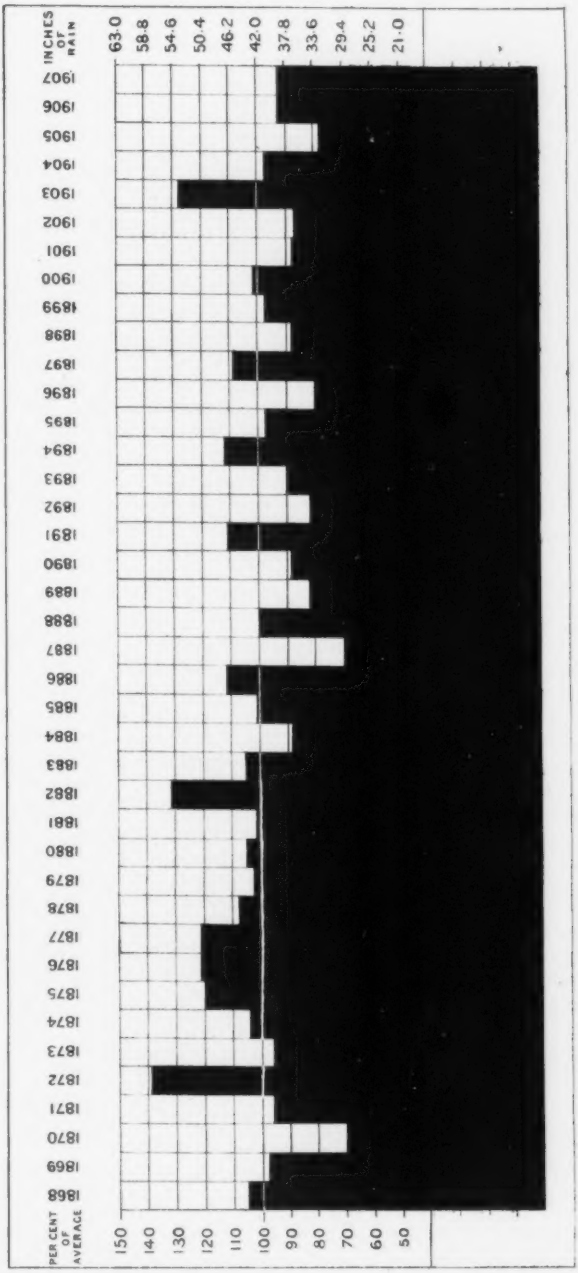
FLUCTUATION OF ANNUAL RAINFALL IN THE EXE VALLEY.



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Year.	Exe valley.	Culm valley.	Creedy valley.	Whole Exe valley.
1897	109	111	107	109
1898	90	85	89	88
1899	97	96	99	97
1900	104	100	98	102
1901	87	89	88	88
1902	86	89	86	87
1903	130	128	123	128
1904	97	97	100	98
1905	78	78	78	78
1906	97	90	87	93
1907	92	94	94	93
Average	100	100	100	100

The final result is given in graphic form in the diagram, where the black columns show the relative total rainfall of the individual years from 1868 to 1907, the average line being ruled through horizontally at 100. The diagram is graduated on one side in percentages of the average, and the approximate equivalents in inches, taking the average as 42 inches, are added on the other side.

The relations as brought out by this diagram are extremely interesting, the more so as the form is exactly similar to that of diagrams constructed for other large areas in the British Isles * and for individual stations in most parts of the country. The variations represented cannot be viewed as local; but, on the other hand, our present knowledge does not justify us in saying that there may not be differences in the phase and amplitude of the deviations between one part of Great Britain and Ireland and another.

In the Exe valley the years 1870 and 1887 were the driest, 1870 appearing here to have been slightly drier than 1887, though in most parts of the British Isles the driest year was 1887.† Between those two very dry years there were only two which fell below the average, and these only by a little. From 1874 to 1883 there were ten consecutive years all of which were above the average, and the mean rainfall of these ten years was 12 per cent. above the average. From 1888 to 1905 there were, as in most parts of the British Isles, six recurrences of groups of three years, one of which had more and the two following had less than the average rainfall. The remarkable uniformity of this repeated sequence of one wet year followed by two dry years cannot be due to chance, but suggests a definite cycle of meteorological changes with a period of very nearly three years. The fact that this periodicity was not apparent before 1888 prepares one for its disappearance, and that appears to have resulted in 1906. It is difficult to imagine any set of conditions which suddenly came into existence in 1888 and suddenly ceased eighteen years later, so that we are compelled to view the three-year period as a physical fact, changes being due to the period being really different from three years by a small fraction, or to the superposition of some other recurring change of different period. It is evident that by taking the ten-year groups with which we have been dealing, we have obtained the impression of a progressive diminution of rainfall, the periods running—

107, 103, 95, and 95 per cent. of the average.

* See Water-supply Memoirs of the Geological Survey for Lincoln, Suffolk, Yorkshire (East Riding), Northampton, and Bedford, Oxford, Kent, Sussex, Hampshire. (Some of these are not yet published. 1909.)

† See H. R. Mill, "The Mean Rainfall of the British Isles," *Min. Proc. Inst. C.E.* vol. **155** (1903-4), pt. i.

By commencing in 1872 the first three ten-year periods would be even more eloquent of a progressive drying-up of the country—

112, 99, 94 per cent. of the average.

Dividing the whole into eight groups of five years each, we have the means—

102, 112, 110, 95, 93, 98, 92, 98 per cent. of the average,

and dividing it into ten periods of four years each, we have the successive figures—

92, 115, 113, 111, 93, 95·5, 95·5, 93·5, 101, 93 per cent. of the average.

Finally, taking three-year periods, they run—

91	110	115	111	113	98	94	94	94	96	96	101	90
or 88	113	121	105	113	100	84	94	100	92	96	104	88

according as the first year or the last year is omitted to make the series complete.

Viewed in all these various groupings, the very high rainfalls of the years from 1872 to 1886 appear to be abnormal features, following a succession of years with much lower rainfall, and followed in turn by a succession of years with lower rainfall. Trustworthy records do not go far enough back to enable us to judge whether a recurrence of a long series of wet years is to be expected in the early future; but they are sufficient to show that the diminution of rainfall is not progressive, but that even the three-year groups tend to recur in a succession of one wet followed by two dry, suggesting a nine-year period superimposed on the three-year period.

The four periods of nine years each from 1870 to 1905 have the mean values 108, 102, 94, 97 per cent. of the average, showing a distinct recovery from the lowest values, and suggesting that the following nine-year period might rise above the average again. In any case, we can see no reason for supposing that there is a progressive diminution of annual rainfall, though a comparatively dry spell has succeeded a comparatively wet spell.

NOTE ON RAINFALL AND STREAM-FLOW STATISTICS.

By **WILLIAM GORE**, Assoc. M. Inst. C.E., and **D. HALTON THOMSON**, B.A.

The flow of rivers and streams, and the manner in which it is related to rainfall, are subjects to which much consideration has been given, especially in connection with water-supply and allied purposes. The authors have been making further investigations into the matter primarily from this point of view, but some of the results accruing therefrom and set forth below have, they believe, a more general scientific interest.

The amounts of rainfall and of water consequently discharged by a stream vary enormously, not only from one season to another, but also from one year to another. Like all meteorological phenomena, they are the result of such a complexity of causes that to predict either of them during a comparatively short definite period is at present impossible. The occurrence of a discharge or fall of given magnitude at any time is then a *chance* event. An attempt, therefore, has been made to apply the mathematical theory of chance to stream-flow and rainfall records, and it has been found that quite definite information may thus be obtained as to the general character of such observations, even though they cover a more or less short period.

The two most important points in statistics of this kind to be determined are the maximum and minimum probable occurrences. Now, the given observations must of necessity be limited in number, and it is obvious that at some future time

the recorded maximum may be exceeded and the minimum reduced. From a mere inspection of the figures it is impossible to make a sound estimate of this probable excess or deficit. The problem is, therefore, to find some means of extending the information at hand beyond its experimental limits, and so to determine the amount by which the extreme records may be broken and the probability of the occurrence. If it is possible to discover the law of probability which has held in the past, it may be employed with some degree of confidence to predict events of the future.

To this end the data was arranged in the form of "frequency curves." Thus, Fig. 1 refers to the annual rainfall at Greenwich, the record extending over 67 years.* The points plotted are for every consecutive twelve months' rainfall, advancing by steps of one month—the first record from January to December, the next from February to the following January, and so on, thus giving 793 observations. The horizontal line is a scale in which the mean annual rainfall of the 67 years is unity. The number of cases in which the amount of rainfall was between 0·8 and 0·9 of the mean is plotted vertically above 0·85. Similarly, the number of cases in which the amount lies between 0·9 and the mean is plotted over 0·95, and so on. In this way the points indicated by the small circles were obtained, the vertical scale being arranged to give the average number of annual returns per century occurring between differences of 10 per cent. of the mean annual rainfall.

In Fig. 2 the daily gaugings of the River Severn,† maintained for ten years at Worcester, are plotted (3652 observations). The unit of the horizontal scale is the mean daily discharge, and the vertical scale gives the average number of daily records per annum occurring between differences of 10 per cent. of the mean.

Fig. 3 refers to the daily gaugings of the Connecticut river,‡ taken for twenty years at Holyoke, Mass. (7305 observations), and the points are plotted in the same manner as those of the river Severn.

Now, the value of plotting the records in this way arises from the fact that the points, when there is a sufficient number of them, lie practically on a smooth curve which, the authors find, may be well represented by an equation of the form—

$$y = \frac{Nw}{C\sqrt{\pi}} \cdot \frac{dT}{dx} \cdot \epsilon^{-\frac{T^2}{C^2}}$$

where $T^2 = \dfrac{ABx^2}{(A+x)(B-x)}$

$$\text{whence } \frac{dT}{dx} = \frac{\sqrt{AB}\left[AB + \frac{x}{2}(B-A)\right]}{(A+x)^{\frac{3}{2}}(B-x)^{\frac{3}{2}}}$$

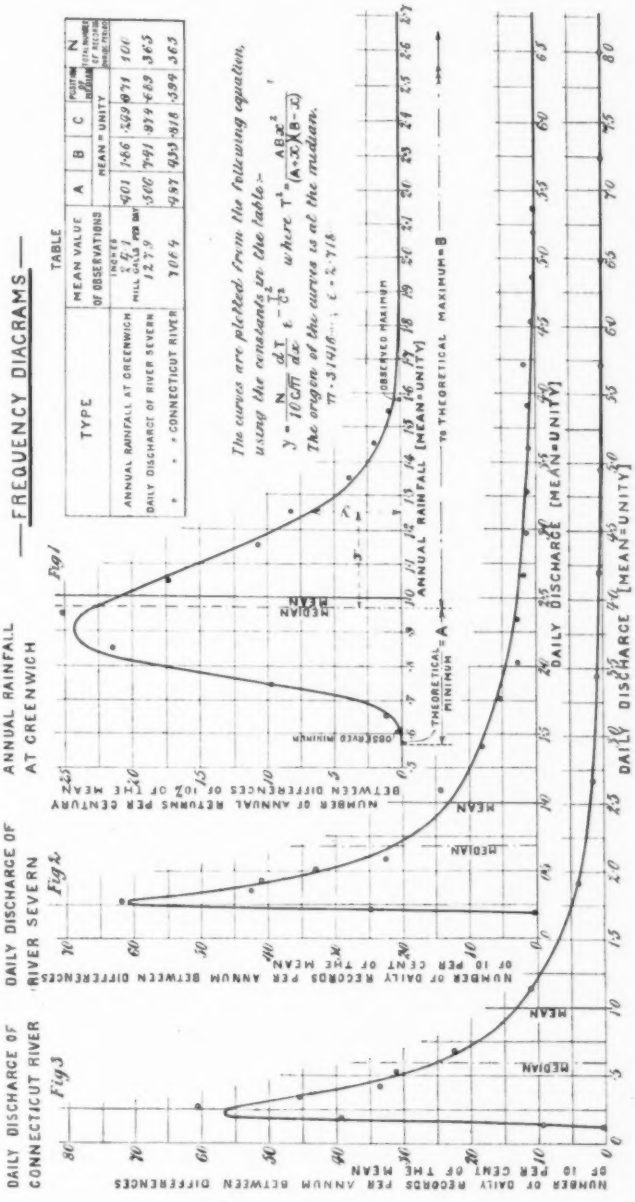
The origin is at the "median," this being the vertical line which divides the area between the curve and the horizontal scale into two equal parts. The height of this vertical is equal to $\dfrac{Nw}{C\sqrt{\pi}}$.

y is the frequency, or number of records out of a total N that occur in a vertical strip of width (difference) w. In the above examples it has been assumed that $w = 0{\cdot}1$ of the mean. x is the magnitude of the records measured from the

* Table in 'British Rainfall,' 1879, p. 11, and following volumes.

† The data have been used by permission of the late Mr. G. F. Deacon, LL.D., under whose direction the observations were made.

‡ Table given by Mr. Clemens Herschel, M. AM. SOC. C.E., in *Trans. Am. Soc. Civil Engineers*, vol. 58, p. 31.


—FREQUENCY DIAGRAMS—
TABLE
TYPE
MEAN VALUE OF OBSERVATIONS
A
B
C
N
ANNUAL RAINFALL AT GREENWICH
INCHES 2.471
401
166
·289
·971
100
DAILY DISCHARGE OF RIVER SEVERN
MILLS PER SQ. MILE 12.79
500
741
·939
·689
365
" " CONNECTICUT RIVER
704
493
·918
·399
365
The curves are plotted from the following equation, using the constants in the table:-
$y = \frac{N}{10\sqrt{m}} \frac{dT}{dx} e^{-\frac{T^2}{2}}$ where $T = \frac{AB x^2}{(A+x)(B-x)}$
The origin of the curves is at the median.
$\pi = 3.1416$ ... ; $e = 2.718$
Fig 1
ANNUAL RAINFALL AT GREENWICH
NUMBER OF ANNUAL RETURNS PER CENTURY BETWEEN DIFFERENCES OF 10Σ OF THE MEAN
OBSERVED MINIMUM
THEORETICAL MINIMUM = A
MEDIAN
MEAN
ANNUAL RAINFALL [MEAN = UNITY]
THEORETICAL MAXIMUM = B
Fig 2
DAILY DISCHARGE OF RIVER SEVERN
NUMBER OF DAILY RECORDS PER ANNUM BETWEEN DIFFERENCES OF 10 PER CENT OF THE MEAN
DAILY DISCHARGE [MEAN = UNITY]
Fig 3
DAILY DISCHARGE OF CONNECTICUT RIVER
NUMBER OF DAILY RECORDS PER ANNUM BETWEEN DIFFERENCES OF 10 PER CENT OF THE MEAN
DAILY DISCHARGE [MEAN = UNITY]

median, a negative sign being applied to those below the median; A indicates the theoretical minimum observation; B the theoretical maximum observation; C represents the "divergency" of the observations. The value of $\pi = 3{\cdot}1416$, and of $\epsilon = 2{\cdot}718$. The curves Figs. 1 to 3 have been plotted from the equation for y, the values of the constants A, B, and C, which best enable the curves to fit the observation points, having been determined. These values are tabulated with the diagrams.

The exact method to be adopted in fitting the curves to the observations is still under consideration, as further investigations must be made to determine the proper "weight" to be given to observations in different parts of the curve.

In order to be in a position to appreciate the utility of the curves and the meaning of the constants, it is necessary to understand some of the general properties of frequency curves. The area included between the curve and the horizontal axis is equal to the total number of observations. Now, if a vertical line be drawn at any point in the curve, it will divide the area into two parts, one representing the number of observations whose magnitudes are greater than that at the chosen point, the other representing the number of lesser observations. Hence the probability of an observation occurring above the given point is measured by the ratio of the upper area to the whole area. Similarly, the probability of the occurrence of a smaller observation is given by the ratio of the lower area to the whole area. An example will make this clear.

In the case of the Greenwich annual rainfall (Fig. 1), the horizontal and vertical scales are such that the total area under the curve represents the annual records of 100 years. Suppose it is required to know the probability of the annual rainfall exceeding 1·2 of the mean. The area under the curve above this point on the diagram is equal to 13 years. Thus the probability is $\frac{13}{100}$, or 13 years in a century. The complementary area below this point is 87 years, hence the probability of a smaller annual rainfall is $\frac{87}{100}$. It should be noted that at the median—being the point which divides the area into two equal parts—the chances of an observation occurring on either side thereof are equal.

A point of some interest is brought out by these curves, which, though familiar to statisticians, is not generally well recognized, viz. the mean value of a set of statistics is not necessarily that which occurs most frequently. For instance, the curve for the river Severn (Fig. 2) shows that observations near the mean occur on an average 13 times per annum, while the most frequent value which is at the peak of the curve (the "mode," as it is called) is only 0·27 of the mean, and occurs about 61 times per annum. Further, the median always lies between the mode and the mean, unless the curve is symmetrical, as occurs in some types of statistics, when of course these three ordinates coincide.

It is to be remarked that the curves are based on the observations, and that for the best fit they must extend both above and below the recorded maxima and minima. The curves, therefore, may be utilized to ascertain the probability of events taking place beyond the limits of observation. The fact that the curves are shown to pass far beyond the experimental extremes does not necessarily denote the appreciable probability of a very large or small event, but merely the *possibility* of the occurrence. For, as explained above, probability is measured by the area under the curve, and from a glance at the diagrams, it is evident that this area towards the upper limit of the curves is negligibly small.

With the aid of the equation established for a particular record, it is a comparatively easy matter to calculate for any assumed probability the corresponding magnitude of the observation. For example, in the case of the Connecticut river the upper limit of the curve is 43·9 of the mean; but from the equation it is found

that the maximum discharge likely to occur on an average once in a century is only 9·87 times the mean, and that in 1000 years is 11·2 times the mean. Thus a very large increase in the period of time taken into consideration has but a comparatively small effect on the probable maximum. The maximum that occurred in the 20 years during which the observations were taken is 8·78 of the mean. Similarly for the Greenwich rainfall the maximum annual rainfall likely to occur in a hundred consecutive years is about 1·50 of the mean.

The lower limit of the curves is much more defined, especially in the cases of the two stream-flow curves; indeed, the lower end might with small error be assumed the practical limit. The extreme steepness of the lower limb of the curves seems to point to some force in Nature which prevents the discharge from falling below a very marked minimum. This must obviously depend on the minimum rainfall, and it has already been pointed out that this all the world over shows an extraordinary, though at present inexplicable, agreement.* The Greenwich rainfall curve is not so skewed; a record at or below 0·71 of the mean would occur once in a century (in 1864 the record fell below this value), and the lower limit of the curve is 0·57 of the mean.

The three cases have been described above merely to serve as examples of a convenient and scientific method of comparing the character of rainfall records or stream gaugings. Thus, the Connecticut river, by its greater values of A and B, is shown to be subject to greater fluctuations, both in flood and in drought, than the river Severn; but its smaller value of C indicates a more general uniform distribution of its flow than that of the latter. These curves are also a means of determining the relation of the discharge of a river to the rainfall on its drainage area. It is significant to note that the same equation may be employed to fit curves both to rainfall and stream-flow statistics, whether for short or long periods. In the case of the Greenwich rainfall the frequency curve for only one period—a year—has been treated, but the investigation may equally well be extended to curves for other periods—daily, weekly, monthly, two-monthly, two-yearly, three-yearly records, and so on—the relations of their constants in the equation determined, and possibly a general law for that particular gauge obtained. An examination of river gaugings in a similar manner will probably yield some valuable results. The application of the law of chance to these phenomena opens up a fresh field of inquiry, and it is in this direction that the authors anticipate a rational development of this interesting subject.

After the paper, Dr. STRAHAN: In reply to a question that has been raised, I may say that we hope to get an estimate of the amount of material which is brought down in suspension by the Exe, not only by examining samples of the water, but also by data furnished by the City Surveyor of Exeter. There are two weirs, and between the two the water has to be kept year after year at a constant depth. This has been accomplished by dredging, and, as the amount dredged is known, we have here an accurate measurement of the amount of material rolled along the bottom of the river. It only remains for me to regret, on behalf of some of our volunteers, that they are unable to be present to-day, and to read, themselves, their reports on the various branches of the work which they have undertaken.

Dr. OWENS: With reference to the effect of suspended matter on the density of the water, it occurred to me that if it raised the density it must increase the eroding power of a current on the bottom. I made some experiments with muddy water, and found a very marked effect. Taking the specific gravity with a

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* Sir Alex. Binnie, *Proc. Inst. Civil Engineers*, vol. **109**, p. 110; vol. **155**, p. 340.

hydrometer, I found that water which gave a specific gravity of 1·0 when clear, gave 1·1 when very muddy.

I then tried the effect of shaking up very fine sand in water in a tall glass, and measuring the specific gravity while the sand was settling; in this it rose above 1·15, and gradually sank to 1·0 as the water cleared. It seems to me that this must have a profound effect on the eroding power of a current carrying sand in suspension. I worked out the theoretical effect, and found that a current of water having a specific gravity of 1·15 would at 4 feet per second move a stone twice the weight which a similar current of pure water could move. The diameter of stone which a current can move varies directly as the density of the water and inversely as the density of the stone *minus* that of the water; hence the effect of increasing the density of the water is very marked. It struck me, also, that it might explain why the more heavily charged with suspended matter water is the slower such matter subsides, as it is equivalent to settling in a liquid of higher specific gravity.

Dr. Strahan: Our difficulty so far has been we cannot find a weighable quantity of sediment in the water in the ordinary condition of the river. The general conclusion I have come to so far is, that, as regards erosion, the rivers are inactive for the greater part of the year. Of course, they are carrying matter in solution, but matter in suspension is simply negligible. During the short period of a flood the river is extremely active, but then for a long period erosion practically ceases.

I trust it will be the view of the Department that the inquiry is proceeding as satisfactorily as may be. More help is wanted in various directions; for example, in the measurement of velocities and other observations, and in the collecting of samples of water. Everything is prepared, and it only remains to find volunteers who are able to make observations with sufficient accuracy, and are willing to take the trouble.

THE ALPS IN THE GLACIAL PERIOD.*

By Prof. W. M. DAVIS.

The completion of a comprehensive monograph on the Alps in the Glacial Period by Penck and Brückner affords opportunity for a summary of the results presented as seen from various points of view, and each point of view suggests material enough for an extended essay. Historically considered, the work must give encouragement to every scientist, because of the enormous progress that it shows since the first suggestion was made concerning ancient glaciation, not a century ago; indeed, only about four times as long ago as the beginning of this work. It is truly stimulating to read how our understanding of unseen processes in the geological past and of visible forms in the geographical present has been advanced from the stage of vague surmises to that of strongly supported conclusions in the short period covered by three generations of observers. The general hypothesis of Alpine glaciation, apparently so preposterous when first proposed by Charpentier and Agassiz as to receive ridicule even from men of science, and truly as venturesome an idea as any that geology has brought forth, had already been far advanced by the collection and discussion of a great mass of peculiar and consistent evidence, when Penck and Brückner began their monograph. To the facts then gained they have added many new ones; to the earlier interpretation of the facts they have

* 'Die Alpen im Eiszeitalter.' Von Dr. Albrecht Penck und Dr. Eduard Brückner. Leipzig: Tauchnitz. 1909. 3 vols., 1200 pages; *many plates, figures, and maps.*

given greatly enlarged understanding; they have vastly increased the probability of correct interpretation; and they have placed the subject in excellent form for further progress by future investigators.

Personally considered, the completed monograph must give immense satisfaction to the many friends of the authors who have followed its preparation and publication through two decades, from the time it was undertaken on the northern border of the eastern Alps with the encouraging support of the German-Austrian Alpine Club in 1887, until its content was extended all round the Alps. It was originally planned to consist of about six parts, the first of which appeared in 1901; but eleven parts were needed for its completion in 1908, when the text was closed with a preface in brief review of the whole, and a dedication to "James Geikie, author of 'The Great Ice Age,' and countryman of John Playfair." The work has been carried on with remarkable patience and perseverance, although both Penck and Brückner have had many other duties to perform. The success with which observations by many other students (over five hundred names are cited in the index of authors) and from many fields have been brought into harmonious accord must make every reader add his admiration of the authors' scientific acumen to his congratulations on their completion of so well-conceived a task; for the work has involved nothing less than a re-examination of every local glacial system which descended from the Alps to the piedmont lower lands on the north, west, south, and east, as well as a review of all pertinent literature. The results reached form an indispensable guide for all future students of the subject, a standard from which all future progress must be measured.

The primary object of 'Die Alpen im Eiszeitalter' is geological, although it is the work of two professors of geography. It seeks to determine how often and how far the glaciation of the Alps had varied during the glacial period, and what work was done upon the mountains while they were glaciated. But as in all studies of Pleistocene glaciation the results have a strong geographical bearing, because post-glacial time is so short that the glaciated region still remains very much as the ice left it; hence an account of ice work in the Alps, whether constructive or destructive, is largely concerned with surface existing forms.

During the more than ten years that elapsed between the beginning of the investigation and the appearance of the first number of the monograph in 1901, there was time for the authors to make many interesting discoveries, and to reach certain important generalizations. Of the discoveries, the most significant were, first, a fourth epoch of glaciation, in addition to the three previously recognized; and second, the strong erosive work of the ancient glaciers in overdeepening the valleys that they followed, this being a notable extension of previous views regarding glacial erosion, in which cirques at valley heads and lake-basins near the glacier ends were supposed to be the chief features of this kind. Of the generalizations, the most significant one, not altogether novel, but of essential importance, is set forth in a preliminary chapter on the system of glacial formations, in view of which the reading of later chapters is greatly facilitated. It is here shown that, as far as glacial deposits are concerned, a series of till sheets, terminal moraines, and outwashed gravels is always more or less distinctly and continuously developed on the bordering lowlands outside of the piedmont basin in which the overdeepening of an Alpine valley ends. The typical series of deposits is liable to variation in many ways; and yet, on the whole, it is believed to be so systematic that the discovery of isolated parts of one or more of its members may be taken to indicate the occurrence of the whole series. In the reviewer's opinion, this preliminary chapter would have been given a greater value if it had been expanded so as to include the erosional as well as the depositional work of a glacier system. The

reader might then have had the completed conception of a working glacier at once placed before him in the introductory pages, instead of having, as now, to look for an account of the erosional results of glaciation farther on, where they are described in partly generalized form under subheadings of chapters concerned with the glaciers of particular valleys. It is true that glacial deposition is of greater importance than glacial erosion in recording the successive epochs of ice advance and ice retreat; and hence especial emphasis is very properly placed upon the till sheets, terminal moraines, and outwashed gravels as a means of interpreting geological history; but it is also true that geological history is concerned with erosion as well as with deposition, and that the complete conception of a working glacial system should therefore involve a consideration of what it has done in enlarging valley heads and in deepening and widening valley troughs, as well as in laying down terminal drift deposits.

The system of glacial deposits having been made clear, the work performed by the expanded glaciers of several valleys in the north-eastern Alps is described in detail; first, the outwashed gravels on the piedmont plain; next, the moraines near the valley mouths; third, the valley troughs up to their heads in the axial ranges. Here we find the facts set forth in detail on which the previously stated generalizations are based. We find, moreover, that the clear understanding and interpretation of the facts are greatly facilitated, as far as the moraines and outwashed gravels are concerned, because of the previous presentation of the generalized system of glacial deposits. It is thus shown that there are four sets of glacial deposits opposite each larger valley, the later ones lying on the eroded surface of the earlier ones. Hence it is concluded that the larger valleys of the north-eastern Alps, four times in succession, supplied great ice-streams, which spread forward on the piedmont plain; and that the intervals between these advances were characterized by normal erosional processes, indicating interglacial epochs. The epochs of ice advance are named, beginning with the oldest, Günz, Mindel, Riss, and Würm; the initials of the names being in alphabetical sequence, but spaced so that additional epochs, if later discovered, may be appropriately inserted without destroying the mnemonic arrangement. The several glacial epochs, as well as their glaciers and moraines, are concisely referred to by their capital initials on various diagrams and in the index; the gravels of the several epochs are denoted by the corresponding small letters. While the glaciers of the latest or Würm epoch were receding, moraines were formed during three significant pauses, or stages of retreat; these stages are called Bühl, Gschnitz, and Daun, and are referred to by their Greek initials, β, γ, δ, also in mnemonic sequence. Similar subordinate stages during earlier advances and retreats may be imagined, but their records are all destroyed. Interglacial epochs are not given separate names, but are designated by hyphenating their adjoining glacial epochs, as Günz-Mindel, or Riss-Würm (G-M, R-W). If the announcement of four alternations of glacial and interglacial conditions excites doubt in the minds of British readers, let them study Calvin's recent address as president of the Geological Society of America regarding the glacial succession in Iowa.

The facts of the north-eastern Alps having thus given justification to the general scheme of a glacial system, a tour round the Alps is made, and each larger valley is treated according to the standard plan already established; again with the result of making the appreciative reading of the monograph remarkably easy for a work of so large and varied a content. Some of the valley systems disclose four epochs of glaciation, some three, some only two. Strong contrasts are shown, as had earlier been known, between the broad, gently sloping extension of the northern, particularly of the north-western glaciers, on the Bavarian, Swiss, and French lower lands, and the more abrupt ending of the steeper southern glaciers, which barely

advanced on the plain of the Po, while the eastern glaciers ended within the interment valleys, without advancing in that direction as far as the Alpine border. Sufficient explanation of these differences is found in the unequal altitude and snowfall of the glacial reservoirs, and in the unequal length and form of the valleys of discharge, as well as in the climate of the lowlands on which the ice ended.

The most significant features of this part of the monograph are, undoubtedly, the assemblage of a great number of independent facts, partly of previous discovery, partly new-found by the authors, and the ingenious interpretation of the facts in view of the general conception of a glacial system already warranted for the north-eastern valleys, and now fortified by its wider application. It is hardly possible to invent a better means of verifying a geological hypothesis than the one here adopted. The later chapters show, naturally enough, certain advances in method made during the six or eight years following the preparation of the earlier chapters, as may be seen by comparing the map of the Drau glaciers and its neighbours (p. 1072) with the map of the Traun, Steyr, and Enns glaciers (p. 204). The former brings out with remarkable clearness the higher non-glacial peaks and ridges, and the broad snowfields feeding extensive glaciers. Contour-lines are drawn on the snow and ice surface at intervals of 100 metres.

The close of the monograph contains two valuable chapters. The first one is on the physiography of the Alps during glaciation, in which it appears that the snow-line then was 1200 metres lower than now, but that it then, as now, lay in an arched, not in a level, surface. It is therefore concluded that glaciation was caused by a moderate lowering of mean annual temperature, with a consequent increase in the proportion of snowfall to total precipitation, rather than by a change in the total precipitation. The final chapter discusses the chronology of the glacial period. Here it is shown that the Mindel-Riss interglacial epoch was much longer than the others, and much longer than post-glacial time. It had been shown in an earlier chapter, on the evidence of a certain plant-bearing interglacial deposit, known as the Höttinger breccia, near Innsbruck, that the Riss-Würm epoch was of distinctly milder climate than that of to-day. Particular interest attaches to the attempt to parallel the shorter subdivisions of late geological time, as based upon the remains of extinct animals and pre-historic man, with the later subdivisions of the glacial period.

The value of 'Die Alpen im Eiszeitalter' is not less for a geographer than for a geologist. The geographer will find many kinds of land forms illustrated by repeated examples, described in view of their origin, and all correlated so as to take their appropriate places in the valley systems of a mountain range that has suffered strong glaciation after it had been maturely dissected by normal processes. Among the forms that are to be associated with glacial erosion are the cirques (Kare) of the valley heads and the sharp peaks and serrated ridges between them; the troughs of the over-deepened valleys and their associated hanging lateral valleys; and the knobs, steps, and basins of the trough floors. Among the forms associated with glacial deposition are the till sheets, the terminal moraines, and the gravel sheets or trains, in various stages of dissection, as already mentioned. The systematic combination of these features, repeatedly developed in successive valleys, always varying from the simple type, and yet constant in their relations to it, is a matter of prime importance in geographic descriptions, for it enables one to give a comprehensive account of a great variety of details by briefly naming the system of forms to which the details belong. Moreover, the contrast of these features of glacial origin with those of normal erosion in the parts of the Alps that were not glaciated gives so overwhelming a demonstration of the abundant ability of glaciers to

continue the covering of partly dissected mountains, that this question may be regarded as settled for the Alps beyond the need of further discussion.

Some of the more significant features of glacial origin may be stated more fully. Very characteristic is the transformation of rounded pre-glacial mountain tops into sharp Alpine forms, chiefly by the enlargement of the small pre-glacial valley heads into steep-walled cirques. The deepening of the cirque floors and the recession of the steep walls at their back and sides saps the pre-glacial rounded summits, even to the point of sharpening them into "needle" peaks and serrate ridges. The evidence of this is as follows: First to be noted is the prevalence of rounded waste-covered summit forms in the marginal non-glaciated ridges of the Alps. This is the case even where the rocks are very resistant, as in the mountains either side of the Dora Baltea valley by Ivrea, and again in the mountains of less enduring rocks, as on either side of Como. In both these localities, as well as in many other similar ones, valley-head cirques are absent or small, because the mountains are comparatively low; the lower slopes, however, where large glaciers scoured the mountain flanks and over-deepened the valleys, are distinctly steeper and rougher than the higher slopes. Next to be noted is the progressive increase in the size of the cirques, and the corresponding consumption and sharpening of the mountains as one enters farther among the higher ranges. Finally, the large cirques of the central ranges leave nothing but sharp peaks and ridges between them (p. 287), such as must be produced when domed mountains have large cirques excavated in the upper slopes.

It may be pointed out in this connection that the terms used by our authors in designating the normal pre-glacial forms of the Alps and their glacially sharpened forms is in certain respects unsatisfactory. Mountains with rounded summits, ridges and spurs, for the most part waste-covered, are said to have *Mittelgebirgsformen*; while mountains having sharp peaks and ridges, exposing large surfaces of bare rock, are said to have *Hochgebirgsformen*. These empirical terms were introduced some years ago in view of the contrasts between the rounded, middle-height mountains of central Germany and the sharper, loftier mountains of the Alps. Such terms were permissible enough when neither the distribution nor the origin of such forms was well understood; they are objectionable to-day when it is shown that process and stage of erosion, rather than height of the mountains, are the controlling factors of mountain form. The rounded *Mittelgebirgsformen* are the work of normal processes on massive structures in a late-mature stage of a cycle of erosion; Alpine *Hochgebirgsformen* are produced by strong glacial erosion acting on a lofty mountain range already well dissected by normal erosion. But it does not by any means necessarily follow that sharp forms of this kind, in other ranges than the Alps, are lofty; nor that normally rounded or subdued mountain forms are low. In regions where pleistocene glaciation was relatively weak, round-topped mountains may have an Alpine height. Many of the Rocky mountains in Colorado reach an altitude of 14,000 feet, and yet have *Mittelgebirgsformen*; cirques of moderate size occur in some of the valley heads, without having sapped the summits sufficiently to convert them into peaks: Mount Elbert, the highest of the range, is a broad dome of this kind, with several cirques on its higher slopes; La Plata peak, near by, has been so far consumed by the excavation of cirques that it has a sharpened top, not quite so high as Mount Elbert. On the other hand, mountains of moderate height in Spitzbergen have been severely glaciated, and exhibit pronounced *Hochgebirgsformen*. In the Snowden district of North Wales, rounded *Mittelgebirgsformen* prevail, but they are locally transformed into *Hochgebirgsformen* by glacial erosion; and here, as in the Alps, the sharpened *Hochgebirgsformen* are actually lower than the preglacial *Mittelgebirgsformen* out of which they were carved! Instead

of *Mittelgebirgsformen*, suggestion has been made of the expressive phrase, subdued mountain-forms; and such terms as glacially sharpened, or Alpine forms might to advantage replace *Hochgebirgsformen*.

The armchair form of cirques is well known. The comparatively flat seat is often somewhat hollowed out so as to hold a lake; the steep walls are usually higher at the back than on either side; and the front descends to the floor of the main valley, to which the cirque stands in the relation of a short tributary. A cirque seat or floor stands somewhat lower (100 metres?) than the surface of the trunk glacier which the little cirque glacier joined; the cirques are, therefore, found at a greater altitude in the higher central parts of the Alps than in the lower marginal ridges. Where the growth of adjacent cirques went far enough, the sharp dividing ridges between them is reduced to much less breadth than that of the cirque floors; this is a striking feature of well-glaciated mountains, absolutely unknown in mountains of normal erosion. If the ridges are still more consumed, the cirque floors become united to form a cirque terrace. In regard to the distribution of cirques, it appears that they are better developed on the north-eastern than on the south-western side of the ranges; better where the mountains rose to significant height (500 metres) above the surface of the main glaciers, than where the mountains were less prominent; better where the ranges had been reduced in pre-glacial time to rounded or subdued forms with open valley heads in which deep snows would collect, as is believed to have been the case in the eastern Alps, than where the ranges were too steep to gather heavy snow on the higher slopes, as is believed to have been the case in the Swiss Alps.

The statement of the last-mentioned point in terms of *Mittel-* and *Hochgebirgsformen* is rather confusing. The reader has already learned (p. 286) that the eastern Alps were transformed from *Mittelgebirgsformen* to *Hochgebirgsformen* by glacial action; he now reads (p. 607) cirques are rare in the Swiss Alps because the mountains in that part of the range had not assumed *Mittelgebirgsformen* in pre-glacial time, but were then still *Hochgebirgsformen*. Inasmuch as the previously mentioned examples of mountains possessing *Hochgebirgsformen* are known to have been glaciated, and as their peculiar features are shown to have been of glacial origin, the description of the pre-glacial Swiss Alps as *Hochgebirgsformen* is not easily followed. The text would be better understood if the inferred forms of the pre-glacial Swiss Alps had been genetically described as steep or early mature forms of normal erosion. The difficulty is, that the empirical term *Hochgebirgsformen* is used to include two kinds of sharp-peaked mountains: those of an early mature stage of normal erosion, as well as those of mature glacial erosion following a late mature stage of normal erosion. The intended meaning is, that the lofty rounded pre-glacial forms of late mature normal erosion in the eastern Alps favoured the development of valley-head glaciers which excavated large cirques, and thus sharpened the rounded summits into peaks; while in the western Alps the pre-glacial sharp summits and steep slopes of early mature normal erosion were unfavourable to the development of glaciers and cirques, and hence the summit forms in this part of the range have been less affected by glaciation than is the case in the eastern Alps.

The over-deepening or "troughing" of the main Alpine valleys by glacial erosion and the resultant development of hanging lateral valleys is of great geographical significance. Attention has been often called to these features during the last ten years, but the extraordinary thing is that they received so little attention during the previous hundred years. Playfair's luminous generalization, written at the beginning of the nineteenth century, regarding the "nice adjustment" of declivities in main and branch valleys so that they come together with accordant junctions, ought earlier to have led geographers to note the abnormal relation of the main and

lateral valleys in the Alps and other glaciated mountains. Now that a simple explanation has been found for this abnormal relation, it might be a matter of surprise that the explanation was not reached deductively forty or fifty years ago, were it not that geographers then had little practice in the use of deductive methods. The first full and clear explanatory statement regarding hanging valleys is to be credited to Henry Gannett in his account of Lake Chelan in the *National Geographic Magazine* for 1898. The same explanation was independently reached by Penck a year later, after he had interpreted the pre-glacial piedmont lowland of weak rocks in Bavaria, on which the earliest outwashed glacial gravels lie, as a peneplain; and had traced into the harder rocks of the Alps the remains of corresponding late-mature pre-glacial valley floors, where they were not completely destroyed by later erosion. He then perceived that the restored pre-glacial valleys, ascending at normal gradient into the mountains, stood, as a rule, in almost accordant relation to the lateral valleys. This important discovery was soon extended to other districts and had two important results. It showed that the piedmont lake-basins could not be explained by a bending down of the mountain area in such way as to warp the valleys, for the undeformed valley gradients proved the quiescence of the Alps during late Tertiary and post-Tertiary time; and it showed that the deepening of the main valleys below their pre-glacial floors could not be the work of normal erosion, for in that case the side valleys should have been deepened also. Hence the conclusion was unavoidable that the over-deepening of the main valleys, not only where they hold the piedmont lakes, but much farther up-stream into the mountains, must have been accomplished by glacial erosion. It is no exaggeration to say that the understanding of Alpine valleys has been revolutionized by these new interpretations. Typical illustrations are given of glacial channels or "troughs," with steep sides and rounded bottom excavated beneath the floor of pre-glacial valleys, of which the higher lateral slopes are still distinctly preserved; one view is from the Floiten valley of the Zillertaler Alps (p. 289); a second is from the better known Lauterbrunnen valley of the Bernese Oberland (p. 612); the latter plate is particularly fine.

As is the case with other features of normal or of glacial erosion, the elements of a glacial trough or channel in the bottom of a pre-glacial valley are systematically associated with each other, and when their association is once recognized their description is greatly facilitated. The upper limit of glacial scouring lies on the pre-glacial valley sides above the border of the over-deepened trough. Below the glacial limit the rock ledges are rounded and scored in the down-valley direction of ice motion; above the limit the ledges are of more angular form, with many signs of down-slope weathering. The limit itself is often marked by a slight wearing down of the glaciated surface with respect to the non-glaciated. When the trough in the valley bottom is well defined, with steep side walls, it may deserve to be described as U-shaped in cross-section; and as such it has a distinct shoulder at the upper trough border. But in many strongly glaciated valleys, where over-deepening is proved by the occurrence of hanging laterals, the cross-section of the trough is a catenary curve or an open, round-bottomed V. It is the opinion of the reviewer that the U-shaped trough, with side walls sloping 60° or more, is to be associated with a young stage of over-deepening in resistant rocks, where the eroding glacier had not time to carry its work further forward to the stage of widening its channel after the deepening was practically completed; while the broadly opened, round-bottomed troughs, with side walls sloping 40° or less, indicate a more advanced stage of trough erosion reached in the same period of time as the others, but in rocks of less resistance. It is in any case clear that glacially over-deepened valley-troughs are not always U-shaped. A single valley

may show both types, as in the valley of the Dora Baltea, which has a fine U-shaped section just above Ivrea, and a wide open form near Aosta. It would be an advantage if the various unlike troughs of the Alpine valleys—and the various unlike cirques of the mountains, and the unlike mountains also for that matter—had been characterized in terms of their stage of development; and inasmuch as the authors of 'Die Alpen im Eiszeitalter' employ with satisfaction such a term as "old age" (*Greisenalter*) in describing the peneplain of normal erosion at the base of the Bavarian Alps, it is somewhat a matter of surprise that they do not make more use of a genetic and developmental terminology in describing features of glacial erosion. It is manifest that the erosion of a trough or channel by a valley glacier is not an instantaneous work; the work must be progressive, and a significant period of time must be allowed for its mature accomplishment. Evidently a less accomplishment in the way of excavating the trough and smoothing its bottom and sides is to be expected in some cases than in others, for the factors of time (as dependent on the beginning and ending of the glacial epochs), glacial efficiency (as dependent on depth, breadth, and velocity), and rock resistance (as dependent on composition, structure, etc.) are all variables. What more natural, then, than to find in the Alps, as well as in other glaciated mountains, valley-bottom troughs of unlike perfection or maturity—some with ragged walls and uneven floors, others with smoother walls and floors. The trough floors often show shallow basins, transverse ridges, and rather abrupt steps; but these inequalities are no larger in proportion to the ancient glacier that overfilled the trough than similar inequalities in immature river channels are to their rivers.

Hanging lateral valleys are, whether treated inductively or deductively, as essential features of a glacial system as are the rock scorings and the terminal moraines. Yet how few of the many thousand visitors at Chamonix have appreciated the relation of the hanging Mer de Glace valley to the over-deepened trough of the Arve! Hanging valleys abound in the Alps; they are absent from normally eroded, non-glaciated mountains of mature or late mature development, such as the Alps were in pre-glacial time. The height at which they mouthe above the main trough floor varies inversely with their drainage area. Associated with the larger hanging lateral valleys is a somewhat sudden gain in the depth of the main trough floor. It may be well to point out that hanging lateral valleys can occur under three unlike conditions of glacial erosion. First and simplest, such valleys occur where a trunk glacier creeps down the farther part of a main valley where no branch glaciers are received from the lateral valleys. Here the main glacier excavates its trough, and leaves the lateral valleys hanging above the trough bottom. Many cases of this kind occur in the Alps; for example, along Lakes Como and Maggiore. They suffice to disprove the explanation of hanging valleys by the assumed protective action of side glaciers, for here no side glaciers existed. Second, and rarest, hanging lateral valleys may occur where a trunk glacier deepens its valley so rapidly that the side glaciers are left hanging above it and join it in ice cascades. This is analogous to the case of normal hanging laterals, which may occur where a very young trunk river deepens its valley so rapidly that its small side streams are left hanging above it and enter it as waterfalls. Such normal hanging valleys are rare, but they are nevertheless known to occur, and are well understood. Corresponding cases in a glacial system are deductively conceivable, but they are not yet inductively proved to exist. Third, and most interesting, lateral valleys must remain hanging, however long they are eroded by trunk and branch glaciers, provided the glaciers are of unequal size, for perfectly as the glaciers may succeed in bringing about accordant junctions at their surface, the beds of their channels (troughs) must persistently join at

discordant levels. It is manifest that the prevalence of hanging lateral valleys in glaciated mountains finds a much more satisfactory explanation under this interpretation of glacial erosion than by means of any other theory yet suggested.

The hanging relation of trunk and branch valleys is seen where distributaries are given forth as well as where tributaries are taken in. This point deserves emphasis, not only because it is to be expected that massive glaciers should often give forth distributaries, especially in the marginal parts of a mountain system where the ice may overflow across a lateral pass from its own valley into an adjoining valley, but also because many examples of this kind occur in the Alps. All such passes of overflow are more or less deepened and rounded out by the distributary ice-stream; fine examples of this kind are seen in the Brunig pass, where a distributary of the Aar glacier ran out to Lake Lucerne; at Monte Cenere, where a distributary of the Ticino (Lake Maggiore) glacier ran out to a western arm of Lake Lugano; as well as back of Menaggio, where a distributary of the Adda (Lake Como) glacier ran out to an eastern arm of Lake Lugano. When a mountain range is briefly described as having been "severely glaciated," after having been subdued by normal erosion in pre-glacial time, distributary passes of this kind are to be expected, along with other systematically developed features of glacial erosion.

The marginal lakes of the Alps, long discussed as to their origin by glacial erosion or by valley warping, are convincingly treated in the Penck-Brückner monograph. The two main considerations have already been mentioned: first, the warping of normal pre-glacial valleys is excluded by the discovery of the remnants of pre-glacial valley floors above the walls of the over-deepened troughs, and by the demonstration that the remnants still stand at altitudes which reveal a normal, undeformed valley gradient; second, the efficiency of glacial erosion is abundantly proved by the form of the valley-bottom troughs and the attitude of the hanging lateral valleys, entirely independent of the occurrence of lakes. Brückner's account of Lake Zurich is of special interest in this connection, for it will be remembered that Aeppli, not many years ago, gave an elaborate account of this lake as a warped valley, in which ice action had had rather a protective than a destructive effect. When the evidence set forth in 'Die Alpen im Eiszeitalter' is supplemented by Wallace's argument, the glacial origin of the subalpine lakes would appear to be convincingly established; this argument being in effect that normally eroded mature valleys must have side valleys entering at grade; and hence, when such valleys are warped, the resulting lakes must have many lateral bays; whereas the subalpine lakes have practically no lateral bays, as must be the case if they are simply the water-filled distal parts of glacially over-deepened valley-troughs.

It should, however, be noted that all the evidence here cited regarding the glacial origin of lake basins depends on a rational and not an empirical treatment of land forms; and hence that geographers who are accustomed to treat land forms empirically rather than rationally will not find the evidence convincing. Those, on the other hand, who realize that the erosion of land forms is not a haphazard process, and who are familiar with the well-developed interdependence of all features in a subdued mountain range of normal erosion, will find themselves driven to the conclusion above summarized, and this in spite of our comparative ignorance regarding the processes of glacial erosion. Scouring and plucking are undoubtedly of value; it is, perhaps, possible that pressure—melting and—freezing may play an important part in the process, as has lately been suggested by some of the Alpine observers; not simply that this process may aid by detaching large blocks, but even more by disintegrating the bed-rock, into the pores of which the pressure-molten water is driven, there to freeze again.

The value of 'Die Alpen in Eiszeitalter' to geographers is twofold, as above stated. It describes many examples of many kinds of land forms in view of their origin; and it correlates these forms so that they all take systematic and orderly position in the valley systems of a glaciated mountain range. An explorer who now masters the details of a glaciated valley system, as he might a score or more years ago have mastered the details of a normal valley system, will find himself thereby vastly better equipped for intelligent and effective observation, than if he sets out on his journey with only an empirical knowledge of land forms. A reader who is familiar with the systematic distribution of parts in both normal and glacial valley systems, is far better prepared to appreciate the descriptions of well-equipped explorers than if he regarded all the items of land forms separately. But there is still further progress to be made. The details of a normal valley system vary, not only with their place in the system, but also with the stage of development that the system has reached: for this reason, it is helpful to use such terms as young, mature, and old in the genetic descriptions of normal valley systems. Likewise the features of a glaciated valley system must vary with its stage of development. Although we are as yet not well informed as to the changes in glacial valley systems as they pass through youth and maturity to old age, it cannot be for a moment doubted that they do suffer a sequence of changes as time passes; and it is now the evident duty of the glacialist, be he geographer or geologist, to determine what this sequence is, and to propose terms, such as young, mature, and old, by which its stages may be briefly and suggestively designated. Still further, just as normal cycles of erosion, one following another, produce a compound topography, and just as the character of the compound will depend on the stages reached in the several cycles, so normal and glacial cycles of erosion may be combined to produce a compound result, and the character of the result will depend on the stages reached in the several cycles. The Alps show us a compound of, for the most part, normally subdued (or late mature) mountains, several times severely glaciated, and now suffering normal erosion again; but we may conceive many other combinations. The Rocky mountains of Colorado were moderately glaciated after having been normally subdued. Norway has been intensely glaciated after the immature dissection of its uplifted highland. The heavy glaciation of the Laurentian uplands acted on an immaturely dissected peneplain. With the accumulation of such examples many idealized concepts must be elaborated, just as Penck and Brückner elaborated the concept of the terminal Alpine drift deposits; and these idealized concepts must include all sorts of compounds of all kinds of mountains and all degrees of glaciation. The thoroughly prepared specialist in the exploration of land forms must, in the near future, be as well acquainted with the many combinations and permutations of these and other factors as the practised sportsman is with the ways of his wild game. All future studies of glaciated mountains will find their indispensable foundation in 'Die Alpen im Eiszeitalter.'

HUMAN GEOGRAPHY.*

M. Reclus (who died before the complete publication of his last work) says that Man is Nature becoming conscious of herself, and from this standpoint he attempts a broad survey of the circumstances which Nature provided for early man, and

* 'L'homme et La Terre.' Elisée Réclus. 6 vols. Paris: Librairie Universelle. 1905–08.

of the work of mankind in adapting itself to those circumstances, and also in altering them here and there by adding new factors which have influenced succeeding generations. In studying present-day human facts, it is obviously necessary to see into not only the underlying physical non-human facts, but also the facts of the past. Esquimault was chosen, for reasons of a physical nature, as a harbour for the navy, but a speedy change of policy brought about the decay of this township without a past. Bristol, on the other hand, while owing its original importance and its site to reasons of physical geography, maintains its greatness in spite of many vicissitudes of trade; the accumulated momentum sprung from a long business tradition has tided the city over serious crises between the decay of one business and the evolution of another. One can, indeed, never assert what facts may and what facts may not be of geographical import, and M. Reclus boldly assumes that nothing human is foreign to his scheme. This makes the work in a sense a sketch of human evolution as well as a geographical study of the ways and works of the race. The net is large, and the meshes occasionally very fine, but it is obvious that no author can make himself a specialist in all departments of human knowledge, and the result is that M. Reclus's statements are frequently open to detailed criticism by the possessors of special scholarship. The work is, none the less, valuable and interesting, for there is much to be gained from a broad survey, which often suggests correlations and interweaving of influences the specialist might otherwise disregard.

M. Reclus's writing illustrates in most interesting fashion one of the greatest difficulties of work on human evolution, the tendency to sink back from the high and difficult line of scientific observation and inference, aided by the use of the imagination so valuable for work on mankind, and to indulge in criticisms and discussions, of which the primary interest is the light they shed on their author's own personality. We often find the author digressing for several pages on topics which are hardly germane to a geographical study, in order to set forth his individual views even on such controverted questions as those of religion. In this connection it may be said that this book is written from the standpoint involved in the national motto, "Liberté, Égalité, Fraternité," and that it is strongly anti-clerical. The book is therefore essentially a book to be studied very critically, but, remembering this, it is still possible to read its easily flowing sentences with pleasure, and to derive mental profit from its many-sided contact with human affairs.

The book seeks to relate human facts to the underlying physical circumstances at every point, and thence shows very clearly how much more dominant and exclusive was the influence of those immediate circumstances in early days than in more civilized epochs, when, nevertheless, the effects of that dependence on circumstance steal subtly through the strongest artificialities of social convention. The Eskimo hunters must be able to resist the pangs of hunger often for long periods, and this is reflected in their training of the young and in their physical and general characteristics. Many African tribesmen of the tropical plains must, on the other hand, be always on the alert and always fleet of foot, and in connection with this we find them frugal in their meals, of spare strong figure, and with senses keener than the average.

As a Western, M. Reclus naturally takes for the main thread of his narrative the influences operating upon Western civilization, and considers other peoples more especially in their relation to ourselves. This explains an emphasis on such subjects as the Jews and their religious ideas, an emphasis which at times leads the author far away from the business in hand—that of tracing the mutual influences of the Earth and man.

The introductory survey deals with prehistoric man as known from the remains which have been found, and discusses in a general way his circumstances during the glacial period in Europe, in each case without raising any specifically new points. From this basis the author builds up an interesting account of the various types of incipient societies as they were probably influenced by their surroundings,—by heat and cold, by drought and damp, by mountains, steppes, forests, rivers, marshes, lakes, islands, and the sea. In this connection the important point is made, that it is unwise to imagine a regular succession of sociological types, *e.g.* from gatherers to hunters, thence to pastoralists, and so on to agriculturalists, and ultimately industrialists. In different circumstances the different activities may appear in very different orders; thus the proximity of a navigable river may lead to the growth of commerce at a very early stage if the difficulty of navigation is surmounted, even ever so crudely. Life in mountain valleys is influenced by deficiency of light, by the streaming dampness of the hillsides, by the difficulties of winter travel, and, still more, of winter labour. The men of such valleys, therefore, descend to the plains to seek work for the winter, and in this way develop the habit of periodical, and ultimately of permanent, emigration which is such a characteristic of the Swiss, the Scotch, and the Welsh peoples. The unequalled difficulties of virgin forests as a home for man are well set forth; the damp semi-darkness and the trackless tangle of undergrowth tend to bring about a supreme isolation and to make the pigmies perhaps the most backward of all human types. Stress is laid on the importance of rivers as channels of intercourse and of unification in many cases, though not in all, for a river may be bounded by marshes which prevent access to its navigable course, or it may flow too strongly to permit navigation. A river can therefore, according to circumstances, become a means of intercourse or the reverse, and cases of both kinds can easily be adduced. There remains the further fact that rivers are found to be convenient boundaries of political states in later times, but political states are only occasionally natural entities.

There is an interesting chapter on the relations of early man and animals, and in it the author lays stress on the likelihood of wild animals acquiring the habit of prowling about the refuse heaps and surroundings of a savage encampment. Once this habit developed, the animals would lose some of their wildness and might come regularly in search of food, thus giving up their shyness towards savage man. Whatever else is doubtful, it is at least reasonably certain that some indefinable and now lost quality made it possible for early man and animals to associate together, and the half-wild visitors to the camp could become pets and ultimately in the full sense domestic animals, the extension of the activity of the mammary glands in the cow being a further triumph in this direction. Reclus claims that the domestication of animals is a far easier step than the utilization and growing of plants, and he gives an interesting case of a monkey which, on its own initiative, did the work of a sheep-dog in Africa. It drove the flocks in, and even mounted them and hunted the parasites in their wool.

Another introductory section deals with the personal organization of society, and thereby touches the thorny controversy of the growth of types of marriage and of the matriarchal and patriarchal arrangements of social affairs. The influence of geographical and other circumstances on the development of these systems is reviewed; the status of women is higher in a sense among tribes which live by gathering and tilling, work in which women may take a large share, than among other tribes living on flocks and herds necessarily cared for and especially defended by the men. Among fisher-folk also the women may gain great social importance, remaining as heads of the household while the men are often only occasional visitors. The Matriarchate and the Patriarchate are thus rival types of social order which, as

Réclus insists, are rarely worked out exclusively; in any one case we shall usually find a mixture of both, and the balance of preponderance of one or other may change from time to time with alterations in the conditions of life. It will be understood that along with marriage and social order comes the question of religion and ceremonial, a subject which is evidently of special interest to the author. His position is that of an anthropological geographer endeavouring to show that all religious beliefs and ceremonies are a natural product, are evolutions from the farthest ages of the past. It is unfortunate that beneath this legitimate argument, there runs an undercurrent of bitterness against current creed and dogma, which is not justifiable in a primarily geographical treatise, and which leads the author into some superfluous and unconvincing digressions.

The periennial question of "East" and "West" naturally comes up for treatment at the commencement of the survey of our civilization, and the reader is wisely warned against such common fallacies as that of an inevitable westward trend in civilization. The natural barriers to intercourse are made responsible, along with the slight development of practical mechanical genius, for the isolation of the various types of civilization in the countries of the East, and special attention is drawn to the great band of inhospitable lands separating these civilizations from those of the Mediterranean and the West. European culture has developed later, and has been influenced again and again by the East, for isolation has not been by any means complete, and the continual mixture of types and social arrangements in Europe has kept the Western civilization in relative instability open to new ideas and progress. The modern vast improvements in mechanical skill and the consequent diminution of barriers, finally, are made to point towards internationalism and the growth of world culture. The author is filled with an ideal of society based upon free criticism and exchange, a society in which national boundaries and prejudices, social inequalities, non-rational dogmas, and other fossils of human evolution shall not have part or lot.

The systematic survey of civilization begins as early as documentary evidence permits, as it is made to start from what may be called the Near East—Iran, Mesopotamia, Egypt, and the countries between. The Pamirs, it is true, are the centre of the great continental arch, but their physical conditions have repelled mankind, and Iran has become the land whence influences radiated to both east and west; it was their place of meeting, and legend has much to say of the age-long conflicts between Iran and Turan.

In treating each region, the approved geographical method is followed of discussing the physical conditions, and especially the relief of the land, from which arguments are drawn as to lines and means of communications, and as to the conditions of social development. Much attention is paid to the human aspect of buildings and other objects of artistic effort, with special reference to the growth of religions. At the outset, the oft-repeated but still very necessary warning is given against generalizing about blood-relationship from the facts of language. The author practically discards the slowly dying Aryan or Indo-Germanic myth.

Phœnicia rightly comes in for special treatment as the meeting-place of three continents, the *entrepot* for the trade of the ancient world, whence the products of the Far East, "spices and balm and myrrh," and also gold and precious gems and ivorywork, valuable materials of sufficiently small bulk to be carried by camels, were brought to the shores of the Great sea and thence distributed to Crete, and Greece, and Egypt, and the barbaric West. Interesting analogies are drawn between Phœnicia and nineteenth-century England, free-trading merchant nations, each, temporarily at any rate, necessary to the general civilization, and each possessing a scattered empire largely based upon trading outposts. The author's controversial

interests lead him to treat Palestine more especially from the point of sciology and theology, and his detailed account borrows much from the results of modern biblical criticism.

It would serve no useful purpose to attempt to follow, within the limits of a short article, the progress of M. Reclus's survey, as he deals successively with the Roman Empire, the Barbarians, mediæval Europe, and the rise of the modern state. In each case the author's aim is to compile an interesting account of the civilization, monuments, and activities of the peoples successively discussed, and one only regrets that his strong personal likes and dislikes sometimes lead him into controversial accounts of political and psychological matters somewhat removed from the main thesis of the relation of man to the Earth. The survey ultimately wends its way around the whole inhabited Earth, and the section on contemporary history gives a broad statement of an educated Frenchman's standpoint in discussing modern international questions.

A rather acid discussion of Britain, especially in its *rôle* as a world power, is of sufficient interest to us to need special mention. M. Reclus seems to see in the well-known British love of continuity of tradition merely a blind conservatism which acts as a drag on the nation. For him the connection between the mother-Britain and the Britains over-seas is a slender one likely to break, and South Africa is treated as a thorn in the side of the empire without a thought of the great scheme of the United States of South Africa which was so soon to be realized. Statistics are given to show the waning of England's industrial primacy, and for the author that was evidently the main feature of British greatness. The administrative work of the imperial civil service is sadly undervalued, while undue attention is paid to the extreme exuberance of British patriotism which has occasionally spread from a few enthusiasts to the mass of the people and infected them usually for a very short time. The British in India come in for special criticism, though the author admires their governmental sagacity, and takes comfort in the belief that British rule is bringing into existence a feeling of "India for the Hindoos." In several sections the author draws attention to the probable immense future importance of the East Indies, where a chain of islands is allowed to belong to Holland for the present but may change hands at any time, and through which opens the great sea-way into the Pacific, the ocean of the future. The concluding chapters contain a survey of modern social systems from the author's standpoint, and continue his criticisms of things British! He gives a caricature of the British Empire, a tall gaunt tourist in a Norfolk suit stalking over the bodies of unfortunate subject peoples, with ironclads emerging from a cloud of black smoke in the background. Other illustrations are a procession of unemployed in London, and a nail-maker, with explanatory details from a report on sweated industries. M. Reclus is almost as critical of most other nations, and evidently distrusts a plutocracy even more than the older types of aristocracy, but, as befits an idealist-anarchist, he concludes in an optimistic tone and looks forward to a successful war against poverty and ignorance, leading on to the realization of an International society of workers based upon "Liberté, Égalité, Fraternité."

H. J. Fleure.

THE INTERNATIONAL GEODETIC ASSOCIATION.

THE sixteenth triennial Conference of this Association took place in London at the Institution of Civil Engineers on September 22, and on the 27th the members of the Association adjourned to Cambridge, where the meeting was brought to a close on September 27. The conference was opened on behalf of the Prime Minister by Mr. Haldane, who welcomed the foreign delegates and expressed the appreciation of the British Government of the geodetic work which was everywhere in progress. Sir George Darwin, speaking on behalf of the President of the Royal Society, who was unavoidably absent, laid stress on the enormous advantage which had accrued to British surveyors in all parts of the world from this country's adhesion to the Association in the interchange of opinions, in the comparison of national standards and in many other ways. General Bassot, the President of the Association, referred to the work done by British mathematicians, physicists, and geodesists for the advance of the science, and welcomed the representatives of the Argentine Republic and Chile, who were present for the first time, these countries having joined the Association since the last conference in Buda-Pesth in 1906. Eighteen countries now belong to the Association and were represented by delegates, and in addition the surveys of the Dominion of Canada and Commonwealth of Australia, of Egypt and of India, sent members of their staffs, so that all the high-grade surveying at present in progress throughout the world was represented at the Conference.

The business of the Conference commenced with the presentation of the report of the perpetual secretary (Prof. H. G. van de Sande Bakhuyzen), wherein he detailed the changes in the Association which had taken place since the last Conference. General reports summarizing the results obtained since the last Conference were presented on the work of the Central Bureau; on international latitude observations; on triangulation; base measurements; longitudes, latitudes, and azimuths; and on precise levelling. On the third day of the Conference other general reports were read on tide gauges, determination of gravity, and deviations of the plumb-line. These reports summarized the advance made in the various sections of geodesy, during the triennial period intervening between the meetings at Buda Pesth and London, and form a valuable record of the present state of geodetic science. In some cases the reporter was able to raise points of considerable interest and importance by the critical discussion of the material furnished to him from different countries. In presenting his report upon the base measurements, Colonel Bourgeois compared those made with bars and with wires respectively, and inclined to an unfavourable opinion of the results obtained with Jäderin wires made of "Invar." This matter is one of great importance on account of the extended use of the Jäderin system of measuring bases at the present day, and the president proposed that the permanent secretary should shortly publish a report on the subject, in which recent results would be incorporated. In the discussion Mr. O. H. Tittman (United States) advocated the use of tapes instead of wires, and Mr. McCaw and Mr. Keeling, from their experience in Uganda and Egypt respectively, laid stress on the necessity for special care in levelling whenever the slope of the ground was considerable.

The representatives of each country presented summaries of the geodetic work which was being done, and many points of interest and importance were brought out. M. Lallemand (France) described the recent French levelling operations, in the course of which two lines were specially re-observed in order to explain certain discrepancies which had been found between the French and Italian levelling at

points on the frontier. The new work showed that these discrepancies were reduced, but enough still remained to suggest the desirability of a similar investigation being made on the Italian side.

Sir David Gill reported on the African arc of meridian, which now extends from Port Elizabeth to a little north of the 10th parallel of south latitude. Beyond this, 250 kilometres of triangulation have been done by the Anglo-Congolese Boundary Survey party, as well as 220 kilometres in Egypt southwards from Cairo. The results of several special investigations of high interest were laid before the Conference, amongst others, those obtained by D. Hecker in studying the deformation of the Earth by the Moon's influence, which he has been measuring at Potsdam with a horizontal pendulum. Baron Eötvös presented a report on his observations with the torsion balance in Hungary. Mr. Hayford, of the United States Coast and Geodetic Survey, presented a new method of computation of the effect of topography and of isostatic compensation upon the intensity of gravity at stations, in which he computed the effect upon the intensity of gravity at each station of all the topography of the world and of the isostatic compensation of that topography, instead of considering the region within a radius of 50 kilometres only. He maintained that the investigation showed both that isostasy exists, and that by extending the region for which compensation was applied apparent anomalies were much diminished.

Throughout the proceedings frequent evidence was given of the immense value of the work done at the Bureau International des Poids et Mesures at Bréteuil, near Paris, in undertaking investigations, in verifying standard weights and measures, and maintaining a high standard of international precision. India has had its 10-foot standard reverified, and is about to adopt metric standards for its geodetic work. Egypt is obtaining a prototype standard metre to replace the Brünner-Ibañez standard bar, which will be reverified at Bréteuil.

It is the combined results of such precise and highly specialized investigations as these, which have been laid before the Conference, that enables us not only to arrive at a more definite knowledge of the Earth's true form and dimensions, but also to locate positions on it with high accuracy for the purpose of controlling innumerable other measurements which are needed for practical purposes. As land becomes more valuable and more subdivided and more densely inhabited, so have measurements of it to be more accurately made; and those of higher grade, which serve as a final control and a guarantee of accuracy, must be carried out with strict regard to all the refinements and precision known to modern geodesy. It is by encouraging and facilitating such specialized investigations, and by co-ordinating the work done in different countries that the International Geodetic Association performs a task of the highest value and importance to state surveys, to all problems of geophysics, and to the whole science of geography.

H. G. L.

REVIEWS.

EUROPE.

GERMANY.

'Deutschland.' By Prof. Dr. Albert Zweck. Leipzig and Berlin: Teubner. 1908. 4 *marks*.

THIS book is practically a regional geography of Germany written from the point of view of the connection between physical condition and economic development. It contains a number of well-chosen illustrations typical of German scenery. Especially interesting are those which show the northern heather and peat regions

and the shifting sands of the Baltic coast. On p. 128 is a typical picture of the drainage of peat bogs. The methods in use nearly resemble those employed in Somerset. On p. 133 is a view of the rescue of a horse from a dangerous bog in the region of shifting sand, and on p. 134 is a typical picture of the vegetation of the Kurische Nehrung. An admirable account is also given of the drainage of marshes and the rescue of land from the sea.

Throughout the books means of communication are well described, and the connection of local industries with the physical features clearly emphasized. Particular attention is paid to the part played by rivers in the commercial development of Germany, the Rhine south of Switzerland being very fully dealt with. Students of commercial geography will find this an admirable book of reference for the account of modern developments such as the use of water-power, and for many valuable notes on the history of important towns.

A. W. A.

'Leeds and its Neighbourhood. An Illustration of English History.' By A. C. Price. (Oxford: Clarendon Press. 1909. Pp. xxiii., 328. *Maps and Illustrations.* 3*s.* 6*d.*) This book is avowedly an experiment, by a schoolmaster, to whom long experience has shown the necessity of localizing the broad facts of history. We have here, therefore, a history of England in certain aspects grouped, so to say, round Leeds as a central geographical figure, although for his many topographical illustrations of fact the author ranges widely through the county of York. The result should not fail to be of value in the locality for which it is designed; incidentally it provides a useful elementary survey of the story of a great city which has been conspicuously wanting in histories.

'A Tourists' Flora of the West of Ireland.' By R. Lloyd Praeger. (Dublin: Hodges, Figgis. 1909. Pp. xii., 243. *Maps and Illustrations.* 3*s.* 6*d.*) The well-known Irish naturalist here provides a handy volume intended, he says, to serve as a "first aid" for the tourist rather than for the resident botanist. But it may be supposed that resident botanists will be glad of the book, so full is it of detail and of references to treatises of a more individual character. There is a general introduction, then a section divided according to localities, then a similar division according to plant-systems. In the two first, as preparatory to the botanical matter, there is a great deal of general topographical information. To each section there is an excellent index.

'Guides Joanne.' "Marseille" (pp. 56, 156), "Rouen" (pp. 60, 156), "Reims" (pp. 40, 136), "St. Raphael et l'Esterel" (pp. 61, 156). (Paris: Hachette. 1909. *Maps and Illustrations.* 1 *franc.*) These four little volumes continue the series of the well-known French guides devoted to individual centres and their environs. They are well produced, illustrated, and mapped, considering their low price, but some of the type is painfully small, and, in the copies under notice, far from clearly printed.

'Géographie du Tarn.' By Paul Joanne. (Paris: Hachette. 1909. Pp. 64. *Maps and Illustrations.* 1 *franc.*) This is a sixth edition of the little handbook to the department of the Tarn, by the editor of the great 'Dictionnaire géographique.' It contains a useful alphabetical directory of the communes, and has evidently been carefully brought up to date. Some of the plates are rather badly worn. The map belongs to the excellent departmental series in the Dictionnaire.

'La Terre Tremblante. Calabre et Messine.' By Jean Carrère. (Paris: Plon-Nourrit. 1909. Pp. 341. 3 *fr.* 50 *c.*) This is a picturesque account of the earthquake-area of southern Italy by an author who was in Calabria after the

disasters of 1907 and 1908—a volume which will be of no little value for future reference, although in no way a scientific study.

'Portugal: its Land and People.' By W. H. Koebel. (London: Constable. 1909. Pp. xvii., 405. *Illustrations.* 16*s.*) Here a commonplace title is applied to a somewhat commonplace book, a ponderous bulk of glazed paper. It is a purely descriptive volume, but the author has had better opportunities for observation than most visitors would find, and he has quitted beaten tracks to some extent. The photographs, and some of the coloured illustrations by Mrs. Roope Dockery, are very good.

AFRICA.

The Peninsula of Sinai.

'La Presqu'île du Sinai:' Etude de Géographie et d'Histoire (Bibliothèque de l'Ecole des Hautes Etudes). By Raymond Weill. With 9 maps and 1 page geological sections. Pp. ix. + 380. Paris: Honoré Champion. 1908. 15 *frs.*

This work is a valuable addition to the literature on the Sinaitic peninsula, and constitutes the most important contribution made to our knowledge of the geography, geology, and history of the region since the publication of the well-known memoirs of Dr. Hume and the late Mr. Barron of the Egyptian Survey Department. The author appears to have thoroughly familiarized himself with the labours of his numerous predecessors in the same field, and his journeys in 1904–05, in company with Flinders Petrie, who was conducting explorations on the western slopes for the Egypt Exploration Fund, have enabled him to supplement previous accounts by much original material of his own gathering.

The book opens with an essay on the geological structure of the country, the author discussing in turn the great limestone tableland of El Tîh and the area occupied by sedimentary rocks on the western side of the peninsula proper; the complicated district of Magharah, where occur the turquoise mines; and the great blocks and ranges of crystalline rocks forming the central and interior portion of the region. It will be noted that the author agrees with Walther in regarding the whole of the sandstone above the Carboniferous limestone as of Cretaceous (Nubian) age, thus differing from Mr. Barron, who considered the basal portion of the sandstone (below certain well-marked basalt flows) as being connected with the underlying Carboniferous limestone rather than with the undoubted Nubian Sandstone above. According to Weill, the red sandstone below the limestone is at latest contemporaneous with the Carboniferous and most probably Devonian.

The second portion of the book is devoted to denudation, hydrology, botany, and the inhabitants, while the third is descriptive of the present aspects and past history of the more important settlements on the shores of the Gulf of Suez. Subsequent sections deal at length with the various routes leading from Suez into the interior; with the topography and history of the ancient Magharah, and the great massif of Sarbût el Khâdim immediately to the north; and with the topography of the central crystalline ranges, including descriptions of the ruins, convents and so-called oases of this mountainous wilderness.

Not the least valuable portion of M. Weill's work is the detailed bibliography, which will be of great assistance to all subsequent workers in the peninsula. The general arrangement of the book might have been improved, and we could have wished that the spelling of place-names were more in conformity with that adopted by the Egyptian Survey. It is difficult, in some cases, to identify hills shown on the author's plans with those on the maps accompanying Mr. Barron's work, and in some instances the spelling adopted in the text does not conform to that used

on the plans. The latter include a general map of the peninsula south of the latitude of Suez, on a scale of 1 : 800,000.

H. J. Ll. B.

Researches in Central Africa.

'Résultats Scientifiques des Voyages en Afrique d'Édouard Foà.' Pp. xli. + 742. Paris: Imprimerie Nationale. 1908. 50 *frs.*

It will be at once seen, from the wording of the title, that this ponderous tome (weighs nearly 10 lbs.) is not the composition of the distinguished traveller whose name it bears, but, as explained by the editor, consists partly of the copious notes left by him in a somewhat rough state at his death in 1901, and partly of the detailed descriptions by the late M. Hamy and several other specialists of the rich geographical, ethnological, and natural history collections presented by M. Foà to the National Museum and the Trocadero. Although his name is little known in England, he may claim to rank amongst the foremost explorers of modern times, and, apart altogether from the unfinished records of his last great expedition of 1894–97, his remarkable versatility and shrewdness of observation in every branch of the natural sciences are amply illustrated in the completed works that he has left us, describing his earlier excursions to Dahomey, and especially to Nyasaland and neighbouring districts. Such were 'Le Dahomey' (1895), described by the editor as "un document de premier ordre;" 'Mes Grandes Chasses dans l'Afrique Centrale' (1899); and 'Du Cap au Lac Nyassa,' crowned by the gold medal of the French Academy (1894).

It was on his return from the almost exhaustive survey of the Nyasalands (1891–93) that M. Foà received his commission to lead the great expedition across Africa which forms the *pièce de resistance* of the present volume, and establishes his reputation as a leading authority on the geography, the peoples, and the fauna of Central Africa. In the previous undertaking the Nyasa and Lower Zambezi districts had been reached by the West Coast, the Cape, and the late Boer states. Now the start was made from Marseilles (July, 1894) *viâ* the Red sea and Indian ocean, so that the contour of the continent was nearly completed when the traveller and his associates, MM. Barély and Bertrand, arrived at the Zambezi delta. A further investigation of the Nyasa region was then made before the party struck inland.

His two companions being left behind at an early stage, M. Foà continued his memorable journey alone, and largely on foot, from Lake Tanganyika and the Lualaba down the Middle Congo to Stanley Pool, where the mission was broken up in November, 1897, its leader returning by Banana to France before the close of the same year. Then followed his marriage in 1899, and in June, 1901, his untimely death, by which a most promising career was cut short while arranging his copious materials for publication. How great was the loss is well indicated by M. Perrier, who, in a prefatory notice, remarks that in all his expeditions M. Foà had invariably proved himself an eminent geographer, a well-equipped naturalist, a resourceful explorer, while he had ever a special eye for ethnological subjects. "Endowed with a wonderful memory and a highly developed artistic sense, he acquired with surprising ease the languages of the peoples with whom he came in contact, induced them to explain their beliefs and to relate their legends and traditions, thus by dint of tact and patience at last penetrating into their psychology and, so to say, laying bare their very souls."

During the final expedition of three and a half years (May, 1894, to November, 1897), over 6000 miles were covered between the two oceans, either on foot or in frail river craft; some 350 determinations were made for latitude and longitude;

150 points fixed astronomically in the Zambezi-Congo basins; and a large number of altitudes taken almost everywhere. Most of these observations are believed to be trustworthy, except the longitudes, many of which cannot be accepted without reserve. The volume is further enriched by several of the original photographs, as well as of the excellent water-colours and drawings made at various points by this many-sided observer. Thus has been brought together and here reproduced a large part of the abundant data collected during one of the most complete geographical enterprises carried out in modern times. It should be stated that some of these data had already received permanent form in M. Foà's 'Traversée de l'Afrique du Zambèze au Congo français,' which was finished a short time before his death.

Attention should also be called to the series of well-executed maps of the regions traversed, and especially to the twelve highly artistic coloured plates of various species of Siluridæ and other members of the peculiar African fluvial fauna.

A. H. Keane.

Ruwenzori.

'Il Ruwenzori, Relazione Scientifiche.' Vol. 1, pp. 601, *Plates* 74; vol. 2, pp. 286, *Plates* 40. By S. A. R. Il Principe Luigi Amedeo di Savoia, Duca Degli Abruzzi. Milano: Hoepli. 1909. 50 *lire*.

The scientific results of the Abruzzi expedition are thoroughly worked out in these two handsome volumes, of which the first forms a valuable contribution to the natural history and botany of British East Africa, whilst the second is one of the most important works on the geology of Equatorial Africa that has yet appeared.

Many of the plates in the second volume are exceedingly beautiful as photographic studies of the valleys of Ruwenzori, as well as geologically interesting. In the first volume Prof. Camerano discusses the distribution of the Colobus monkey, and describes the sub-species of buffalo (*Radcliffei*) and of the zebra (*Granti*) which occur in Uganda. He also distinguishes the Ruwenzori leopard as a new variety remarkable for its extremely dark colour and peculiar shape. The zoological collection consists of the following:—

Bats, 9 sp. (1 new) and Insectivora, 3 sp. described by Festa; rodents, 17 sp. (*Camerano*); birds, 36 sp. (*Salvadori*); reptiles and Amphibia, 39 sp. (1 new) by Peracca; mollusks, 51 sp., of which 31 are new (*Pollonera*); Crustacea, 3 sp., with 2 new (*Nobili*); Hymenoptera, 28 sp., and dragonflies, 3 sp. (*Zavattari*); Coleoptera, with 4 new sp. (*Camerano* and *Pangella*); earwigs, etc., 24 sp., of which 7 are new (*Borelli*); Orthoptera, 70 sp., of which 6 are new and 1 is a new genus (*Giglio Tos*); termites, 4 sp., and myriopods 21 sp., of which 17 are new (*Silvestri*); worms, 31 sp. and 18 new (*Cognati de Martiis*); Parasitic worms, 16 sp. and 5 new (*Parona*).

The botanical collections include 93 species of flowering plants, of which 18 are new to science (*Chiovenda* and *Cortesi*); ferns, 24 sp. (4 new) by Pirotta; mosses, 38 sp. and 22 new, including 2 Sphagna (*Negri*); Hepatics 33 sp. and 16 new sp. (*Gola*); fungi, 27 sp. and 1 new sp. (*Mattirolo*); lichens, 83 sp. (5 new) by Jatta and Algæ, 33 sp. by De Toni, who records the snow alga, *Chlamydomonas nivalis*, upon Ruwenzori. In the second volume, containing Prof. Roccati's lucid description of the geology of Uganda, there are many interesting points, such as the origin of laterite, native methods of iron-working, and the distribution of ironstone (limonite) through the area formerly occupied by Lake Victoria. He also explains the curious whaleback shape of many gneiss rocks which is familiar to all African travellers. Ruwenzori itself consists of a part of the original Archæan African plateau which has been uplifted as an enormous orographic

block, or *zolla*. The upheaval was connected both with the "grandiose" fault on the western flanks which has resulted in the Semliki valley, and also, on the eastern side, with other faults delineated by the little recent volcanoes of Toro. The ellipsoidal core or anticlinal of Ruwenzori consists mainly of the more resistent rocks, such as amphibolite schists, whilst the easily weathered micaschists are prevalent in the outer zone. Abundant traces of ancient glaciers were detected even at so low a level as 1400 metres in the Mobuku valley. These are ascribed to the Pleistocene period.

There are also articles by Prof. Colomba and Pioliti.

It is unfortunate that the quotations from English works have not been revised and corrected by an Englishman, for there are many obvious misprints in these extracts.

G. F. S. E.

AMERICA.

Mexico.

'In Indian Mexico: A Narrative of Travel and Labor.' By Frederick Starr. Chicago: Forbes & Co. 1908. $5 *net*.

Prof. Frederick Starr's contributions to our knowledge of the physical characteristics of the Mexican Indians are a valuable asset to science. Lumholtz's work covered chiefly north-western Mexico. Starr's very methodical investigations were mostly carried out in Southern Mexico, though they included the Otomis, the Tarascos, and the Huastecos. The present work is the narrative of travel and work covering the author's expeditions from 1895 to 1901. It is intended for the general public.

It is obvious from the start that Prof. Starr does not entertain a very high opinion of the general public. His wayside and camp-fire notes, hurriedly if punctually jotted down, are here presented, or rather dropped, *pêle-mêle*, without any regard for style, without any attempt at a connected and ordered account. Truly the subject-matter is interesting, and the volume is full of curious details. But these are sadly mixed with trivial remarks presented in a most unattractive manner. To the geographer, the task of disentangling and picking up the important facts is rendered well-nigh hopeless. Yet one feels that here was an opportunity for a good book. The materials are there, but unworked. It must be said, to its credit, that this book does not claim to be geographical. Whether it will provide entertainment or information to the general reader may be best discussed elsewhere.

M. H.

'Explorers in the New World, before and after Columbus, and the Story of the Jesuit Missions of Paraguay.' By Marion M. Mulhall. (London: Longmans, 1909. Pp. xiii., 313. *Maps*. 6*s*. 6*d*.) The title hardly suggests that the subject of this volume is practically confined to South America. It is, however, an interesting subject, though the treatment is in parts somewhat formal and dull. The pre-Columban maps, if their reproduction could not be improved, might have been left in perfect instead of partial obscurity.

'Denys: Description and Natural History of the Coasts of North America (Acadia).' Edited by W. F. Ganong. (Toronto: Champlain Society. 1908. Pp. xvi., 625. *Maps and Illustrations*.) The fortunate recipients of the limited edition of this finely produced volume will find Denys' interesting text carefully edited and annotated, and elucidated with reproductions from originals and other illustrations, and numerous good maps. The production is greatly to the credit of the Society.

AUSTRALASIA AND PACIFIC ISLANDS.

France in the Pacific in the Eighteenth Century.

'Les relations commerciales et maritimes entre la France et les Côtes de l'ocean Pacifique' (Commencement du XVIII^e^ Siècle). Par E. W. Dahlgren. Tome I. Paris: Honoré Champion. 1909.

In the number of this *Journal* for last October a contribution by Herr Dahlgren to our knowledge of early French enterprise in the Pacific was noticed. That monograph may be regarded as a syllabus for a larger work by the same author, of which vol. 1 has now been issued in Paris. In this, which appears in French, he has set himself the task of making plain the important influence that trading expeditions from France during the earlier years of the eighteenth century exercised on the development of that nation's commerce, and their bearing on the finances of both France and Spain.

The volume is conveniently portioned into four "books." It is embellished with some neat woodcuts proper to its subject-matter, and has seven maps. In the opening chapter the author describes the ordering of Spanish merchant and treasure fleets, and the system of "protection" or monopoly under which they sailed. This system underwent many modifications until the year 1680, when its provisions were codified in the celebrated *Recopilacion de las Leyes de Indias*.

An outline of the various administrative offices and executive bodies of the Spanish colonies is also presented; and the remarkable powers and functions of the *Consulado* of Sevilla and *Casa de Contratacion*—so difficult for work-a-day people now to comprehend—are usefully explained. The doings of English and Dutch corsairs are noticed in their turn, and the steps by which piracy and filibustering gradually gave way to more legitimate modes of traffic are traced.

Until the close of the eighteenth century Cadiz was the only *entrepôt* from which the ports of Spanish America were permitted to receive imports—and those only in Spanish ships and under harassing stipulations. But most of the linens and cotton goods were the product of French looms. These reached Cadiz from the harbours of Brittany in French bottoms, being transhipped there into *navios de la carera*, which sailed under Spanish convoy twice a year. Many French business men therefore lived at Cadiz or Sevilla, where they doubtless saw and used their opportunities as best they might. We even read that they often overtly did acts of contraband under cover of the guns of French frigates lying in Cadiz bay, ostensibly to watch the legitimate interests of French commerce, but actually to connive at irregular methods of pushing it in the face of Spanish restrictions. If these merchants could prosper while so taxed and hampered, it was natural that they should wish for the freer opportunities and still greater profits of a direct trade.

The father of this trade was one Noël Danycan, a merchant of Saint Malo; and it is with the history of his enterprise and the several ventures in which he and his associates and successors embarked between 1698 and 1713, as well as with the political heartburnings and international negotiations they gave rise to, which culminated in the Treaty of Utrecht, that this volume is chiefly concerned.

Its preparation must have called for the examination of some thousands of documents, and have involved vast and intricate labour. Herr Dahlgren is to be congratulated on having achieved so much and so well, in the midst of his official duties, and in a language not his mother tongue.

There are many points in his narrative which are interesting to Englishmen on account of their relation to the Falkland islands—once known as the *Iles D'Anycan*, and still called by the French *Iles Malouines*, and by the Spaniards *las Malvinas*. An outlying sentinel of the group, named after the commander of Danycan's first convoy, remains known to ourselves as the isle of Beauchesne. B. G. C.

'The Commonwealth of Australia.' By the Hon. B. R. Wise. (London: Pitman. 1909. Pp. xvi., 355. *Maps and Illust.*, 7*s.* 6*d. net.*) This volume is the first of the "All Red" series, and if the standard it sets is maintained the series should deserve wide recognition. The physical, social, political, and administrative conditions of the Commonwealth are carefully treated in all their branches, and by an author with full first-hand knowledge. The book contains a limited number of good photographs, and a moderate map.

POLAR REGIONS.

The Heart of the Antarctic.

'The Heart of the Antarctic,' being the story of the British Antarctic Expedition, 1907–1909. By E. H. Shackleton, C.V.O., with an introduction by Hugh Robert Mill, D.SC., an account of the first journey to the South Magnetic Pole by Prof. T. W. Edgeworth David, F.R.S. In two volumes. London: William Heinemann, 1909. 36*s. net.*

The two fine volumes that record the narrative and preliminary scientific results of Sir Ernest Shackleton's Antarctic Expedition of 1907–9 are worthy of their subject, and characteristic of the spirit in which the work was done. The narrative is of absorbing interest, and at once secures the sympathy of the reader by a rare combination of modesty, with full and free expression of the personality of the authors. Sir E. Shackleton writes in terse straightforward English, and his account of the great sledge journey to the south is a reprint of his daily journal. The journey to the south magnetic pole is also mainly given as a plain record of facts, with occasional flashes of Prof. David's graphic eloquence. Both narratives throb with the spirit of resolute men engaged in a noble quest, ready to run great risks, and yet saved from foolhardiness and disaster by careful forethought, scientific judgment, and cool courage. The risks accepted were heavy. That the members of the expedition all returned seems miraculous. All Alpine rules for the use of the rope and for caution in the traverse of broken ice had to be disregarded; there was simply no time to probe for crevasses, and the explorers had to press forward unroped, and often alone, trusting to snow-bridges they could not test. Hair-breadth escapes were innumerable, and the explorers were continually falling into crevasses. Joyce's party, laying a depôt on the Great Barrier, crossed a hidden chasm that was large enough to engulf the whole party, and was only revealed when the bridge fell in just behind them. The only irreparable accident was the loss of the last pony, which was swallowed up by the Beardmore glacier; but for the loss of this substantial supply of food, the distance between the southern record and the South Pole would no doubt have been considerably reduced.

The book shows that the remarkable success of the expedition was due to the careful planning and equipment by its leader, to the sympathetic tact and insight by which he used the utmost powers of his staff, to the courage, energy, and expert knowledge of all the members, and to the sound judgment which avoided fatal accidents, of which danger always lurked close at hand.

The outstanding geographical results of the expedition are the magnificent feat of sledging to the far south, and there, when the newly discovered mountains bent round and barred the road to the pole, the leader, not content with his great addition to the southern record, forced his way up the Beardmore glacier on to the southern plateau; the journey, under Prof. David, to the south magnetic pole; and the ascent of Mount Erebus, with the discovery of its volcanic history. The results of the expedition are unique. No other expedition has, or ever can repeat the feat of having made the first visit to the neighbourhood of both the geographical and

magnetic poles, and it may be doubted if any polar expedition has returned with such a harvest of illuminating results.

The journey to the south polar plateau is naturally of the widest geographical interest, for the way to the Pole led into the very heart of the unknown Antarctic continent. No other route could have been so instructive to the first expedition to achieve it. The journey proved, as was predicted in 1901, that the scarp of South Victoria Land bends eastward, in the direction of Graham's Land, leaving the pole upon the summit of a vast plateau. Its existence and height near the pole have now been demonstrated, and as Sir E. Shackleton arrived within less than 100 geographical miles of the pole, there can be no doubt that the pole is upon this plateau. Except for the determination of its gradient, the traverse of the remaining distance would probably not have given geographical results of much importance.

The book is prefaced by a masterly summary of previous Antarctic work by Dr. H. R. Mill, who defends Wilkes from the harsh judgments that have been passed on him, and pays a warm tribute to Arctowski, whose ardour, he says, has never been surpassed. The two volumes are magnificently illustrated with instructive photographs of the country, coloured plates by Marston, the expedition artist, who shows that Antarctic colour-effects are as vivid as those of the Arctic, and portraits.

The first volume closes with the return from the Southern Journey. The second is devoted to notes on its results, to an account of the work done from the station during the summer, and to the return to New Zealand. Then follow eight chapters by Prof. David, describing his journey with Mr. Mawson of Adelaide University and Dr. Mackay along the coast of South Victoria Land; their arduous ascent up the Larsen glacier on to the plateau; and their long sledge journey to the magnetic pole. As the breaking up of the sea ice behind them cut off retreat to winter quarters, this expedition was no less daring than Shackleton's, and its success is all the more remarkable as not one of the party had previous Arctic or Antarctic experience. The remainder of the second volume is occupied by scientific appendices and a report by the captain of the *Nimrod* on his attempt to find the Emerald, Nimrod, and Dougherty islands on the return voyage to England, Captain Davis will not say the islands do not exist, but that they do not exist at, or near, their assigned localities.

The story of the expedition is now so well known that geographers will naturally turn to these volumes for the preliminary statement of the scientific results. These are given in a series of chapters in the second volume by Mr. Murray on biology; by Prof. David, Mr. Priestley, and Mr. Murray on the geology and volcanic eruptions; by Prof. David, Lieut. Adams, and Mr. Murray on the meteorology; by Mr. Murray on the tides and currents; and by Mr. Mawson on the physics, chemistry, and minerals.

Mr. Murray, the biologist of the expedition, was impressed with the wealth of the marine fauna and flora. The sea-bed he describes as covered with a living carpet. The expedition had few opportunities of deep-sea dredging, but it made the most of them. Mr. Murray obtained much of his marine material by Hodgson's method of dredging between two holes in the ice. The most important biological results stated in these volumes are the accounts of the rotifers and waterbears found in the lakes and mosses near the winter quarters. Mr. Murray is an expert on these groups, and gives a most interesting account of the tolerance of these animals of low temperatures and intensely saline water. They live frozen most of the year, being thawed only for a few hours a day in the height of summer. The waterbears have long been famous for their powers of resisting high temperatures

and desiccation, and Mr. Murray's work shows their endurance of the other extreme of temperature.

The meteorological data given are not sufficient to settle the existence of the hypothetical South Polar anticyclone, a problem the full report may be expected to solve.

The results of the geology and structural geography of the region are given in valuable appendices by Prof. David and Mr. Priestley. They agree with Phillippi of the German Antarctic Expedition, that the coast of South Victoria Land is of the Atlantic and not of the Pacific type. Of this, the evidence so far advanced is not conclusive, though the arguments on the other side are reduced by the doubt thrown on the existence of a granite intrusive into the Beacon Sandstone, which is greatly reduced in thickness as the lower 3000 to 4000 feet of the Obelisk range as well as much of the Solitary Rocks, turn out to be granite and not sandstone. Prof. David shows that there is no folding parallel to the coast, and that the volcanoes of the Erebus group, and probably also Mount Melbourne, are arranged on transverse fissures; but the great step faults, the submarine ridge between two troughs, and the line of volcanoes all parallel or subparallel to the coast, are features that agree with the Pacific type. Although the writer in 1901 accepted Reiter's view as the more probable, he remarked (*Nature*, vol. **63**, p. 610, footnote) that the sudden change in the southern province of New Zealand from the normal Pacific type to the fractured plateau of Otago, with a different trend, might indicate that the mountains of South Victoria Land were not on a continuation of the New Zealand line. Victoria Land would appear to have the structure that the writer has called the sub-Pacific type, and if it be assigned, for the reasons stated in Prof. David's report, to the Atlantic coast type, so also are the eastern coasts of Australia and Asia, and the distinction between the two coast types will have broken down.

Prof. David's work on the ice structure is of special interest, as he concludes that the ice of the Great Ice Barrier is formed by snow fall and not by glacier ice. This view was suggested from the photographs taken by the *Discovery*, and Prof. David's evidence in favour of it seems conclusive. He shows that the annual snow fall is equal to about $7\frac{1}{2}$ or $9\frac{1}{2}$ inches of rain, so that it would fall as from $7\frac{1}{2}$ to $9\frac{1}{2}$ feet of snow. One puzzling feature is the apparent endurance of this ice to sea-water. Experiments have shown that Arctic ice undergoes rapid solution in sea-water, but the ice of the three floating Ice Barriers described is apparently dissolved very slowly. Prof. David suggests that fresh water ice does not thaw as rapidly as sea ice, though there seems no sufficient physical reason for this difference.

The expedition was fortunate in finding one important fossil, collected by Sir E. Shackleton, from the sandstone during the ascent of the Beardmore glacier. He found several seams of coal or coaly material. A microscopic section from one specimen shows a woody structure, and is identified by E. J. Goddard of Sydney as probably coniferous, and of upper Devonian or lower Carboniferous age. This discovery suggests an approximate date for the Beacon sandstone. One interesting fact discovered by Prof. David, is the formation of peat from a fungus growth in lakes near the winter quarters. Coal-seams may therefore possibly have been formed in the Antarctic even under existing climatic conditions; the fossil-wood, however, indicates some difference in the climate of upper Palæozoic times, though the fact that the repeated and careful search for fossils in the Palæozoic sedimentary rocks recorded none except this fragment of wood and some radiolaria, suggests that Antarctica was poor in life in palaeozoic times. The Beacon sandstones are described by Mr. Priestley as so decomposed that no fossils could have been

preserved in them, but there appears no reason why the associated argillaceous limestones should not have preserved any organic remains. The rottenness of these sandstones and Shackleton's statement, that the rocks further south show the weathering of "countless centuries," suggest that the whole region has not been ice covered in recent times.

It is impossible in a short notice to refer to many of the interesting problems on which these volumes throw important light. The expedition has already secured general appreciation as one of the most successful in the annals of British exploration, and Sir Ernest Shackleton's book shows that the results it secured are amply worth the perils and privations endured in their collection.

J. W. G.

GENERAL.

Photographic Surveying.

'Internationales Archiv für Photogrammetrie:' Organ de "Oesterreichischen Gesellschaft für Photogrammetrie" in Wien. Edited by Eduard Dolezal. Vol. 1. 1908.

Photographic methods of survey have obtained so little hold in our country and its dependencies that it is somewhat startling to find that there exists a society, publishing a quarterly journal, for the study of this subject. This first volume not unnaturally opens with an account of the long-continued and able work of Colonel A. Laussedat, member of the Institute of France, who may in every sense be described as the father of photographic surveying. His first paper, on the use of a camera obscura for topographic reconnaissances, was published in 1854, and his second, on the use of photography in surveying, in 1859. The only place in the British Empire where photographic surveys have been used to any practical extent is in the mountain region of Canada, where the method has been developed by Mr. Deville, the Surveyor-General of Dominion Lands. An account of this work will be found in the volume now before us. In spite of the undoubted skill which Mr. Deville has brought to bear on the problem it cannot be said that the system has in practice proved a complete success. Maps can undoubtedly be made from photographs, but, until definite figures of rate of output and cost are produced, we are justified in maintaining that the method is more costly, slower, and not more accurate than those based on the use of the theodolite and plane-table.

Probably the system of stereoscopic pairs of photographs with an automatic plotting-machine is the only really hopeful line of advance for the future, and presents the only possibility of competing on at all equal terms with the usual methods. The present enthusiasm for aërial navigation will doubtless cause a revival of interest in balloon and kite photographs and in the construction of maps from such data. The volume before us contains evidence of this. It can hardly be said that the results obtained are commensurate with the ingenuity displayed. The Society of Photogrammetry in Vienna takes a large view of its scope, as is instanced by the inclusion of a paper on recent developments in astronomical photography of precision. The services rendered to the advance of astronomy by the introduction of photographic methods are well known and indisputable, but perhaps hardly concern us here as geographers.

There are doubtless many branches of work where the employment of the more rigorous methods suitable to an actual survey would be advantageous, such as the use of photography for making a general survey and record of historical buildings and monuments. Such records cannot fail to gain in value if they contain on their face the data from which all dimensions can be measured with facility and precision.

In conclusion, we may mention that this organ of the Vienna society, though for

the most part in the German language, contains papers both in French and in English. Those of our readers who are workers in this branch of scientific geography, and are in search of an international vehicle of publication may be glad to make use of the opportunity of addressing a large circle of experts. E. H. H.

'Tropical Medicine, Hygiene, and Parasitology.' By Dr. G. E. Brooke. (London: Griffin. 1908. Pp. xvi., 498. *Maps and Illustrations.* 12*s.* 6*d.*) This volume contains a vast amount of matter compressed into a portable size. It recognizes subjects kindred to its own; thus climatology receives a chapter illustrated with maps. Careful tabulation and general arrangement, and a full index, should render the book easy to consult.

'Pioneering.' By F. Shelford. (London: Spon. 1909. Pp. vi., 82. *Illustrations.* 3*s.*) This little volume contains four articles contributed to the *Engineer*, revised, with a preface by Sir G. Taubman Goldie. The information they contain as to travelling and camping equipment is given very simply, and seems in some parts almost needlessly elementary, but is mostly useful and clear.

'The Ocean Carrier.' By J. Russell Smith. (London: Putnam's Sons. 1908. Pp. xi., 344. *Maps and Illustrations.* 6*s.*) We have here "a history and analysis of the service and a discussion of the rates of ocean transportation," according to the sub-title of the volume. It is claimed to be the first in its particular field, and certainly provides ready reference in a handy form to the whole subject of the development and system of the world's oceanic trade-routes. Moreover, it is well written in an interesting manner, and should prove valuable as a text-book in commercial geography.

'Étude sur la Section Coloniale de l'Exposition Franco-Britannique de Londres en 1908.' By Lewis Ware. (Paris: Dépêche Coloniale. 1909. Pp. 430.) This volume deals almost wholly with the French possessions in Africa, though Indo-China is also touched upon. Its interest is purely commercial, and the resources of the various colonies are dealt with in great detail, while for each there is also a survey of colonization, development, and public works. Each chapter is clearly tabulated, and there is an ample supply of statistics.

THE MONTHLY RECORD.

THE SOCIETY.

Captain Scott's Antarctic Expedition.—Under date November 9, 1909, Major Darwin, President of the Society, has written as follows to Captain R. F. Scott: "I have been requested by the Council to write to you to express their hearty approval of your expedition, and to add that you may count on the Society for a contribution of £500 towards the sum needed." The Royal Society has voted the sum of £250 towards the expenses to be incurred for scientific work, while the Corporation of the City of London has, we are informed, decided to contribute one hundred guineas towards the general expenses.

EUROPE.

The Mitchelstown Caves, Co. Tipperary.—Some account of these caves and of a preliminary exploration of that known as the "New cave" was given by Dr.

C. A. Hill at the meeting of the British Association at Dublin last year (*Journal*, vol. **32**, p. 512). When Dr. Hill's paper was read, he had been unable to enter the Old cave, which since the discovery of the New cave in 1833 had been entirely neglected by tourists, though previous to that date it had been fairly well known, and had been well described by Arthur Young in his 'Tour in Ireland.' Immediately after the Dublin meeting, however, Dr. Hill, accompanied by Messrs. Brodrick, Rule, and Praeger, revisited the caves, of which an accurate survey was then for the first time made, the result showing that existing plans of the New cave were far from correct, while no plan of the Old cave had ever been published. A full description of the caves and their exploration, with plans and illustrations, has now appeared in the *Proceedings of the Royal Irish Academy* for August, 1909 (vol. **27**, Sect. B, No. 11). The caves, it should be stated, lie on the north side of the Blackwater valley between the Galtee and Knockmealdown ranges, about midway between Mitchelstown and Cahir. The Old cave possesses considerable historical interest, having probably been the hiding-place of the Earl of Desmond after his futile rebellion in Queen Elizabeth's reign. Its exploration, too, was of the more interest from the almost entire oblivion into which it had previously fallen, and though sadly shorn of its beauties owing to the removal of many of the stalactites for sale during the famine of 1847–48, it is described as still possessing characters hardly to be surpassed in any cavern in the British islands. Access is gained through a fissure in the side of the hill, ending in a vertical drop only to be negotiated by means of a ladder. A tunnel of some length at last bifurcates, the two branches leading to the great eastern and western chambers. The former is the largest and most impressive vault in either cavern, having a total length of nearly 130 yards, while the western chamber, though shorter, is more lofty, reaching at least 80 feet at one extremity. The New cave has a far more complicated labyrinth of passages (reaching a total length of nearly 1½ mile), but no chamber comparable to those of the Old cave. The relation of the caves and their various features to the geology of the district is well described. The valley above alluded to consists of a synclinal trough, its floor composed of Carboniferous limestone—a hard greyish rock. Where the caves are, the strata dip steeply south (30° to 40°), this fact giving the caves many features of interest. The passages and chambers may be grouped under three main types, according to the planes of weakness which have contributed to their formation. Both the chambers of the Old cave are examples of the bedding-plane type. In the eastern one, both floor and roof follow the steep dip of the strata, though converging towards the south, or lower side, which is filled with still, clear water. The second type of passage is the resultant of the bedding planes and the secondary joints, the latter of which run generally east and west and cut through only one bed of limestone at a time. The usual height of these passages is only about 5 feet. The third and fourth types of passage are both due to the main joints, which run north and south and cut through the limestone in continuously vertical lines, sometimes 20 feet and more in height. Some of these fissures seem to have been widened by the action of running water, others do not. The paper includes descriptions of the stalactites (one of the most remarkable of which has been fractured and naturally repaired in a way analogous to that in which a badly set bone becomes re-united); the "cave pearls," consisting of concentric layers of calcite formed round a nucleus; the "anemolites," or stalactites, which during formation have been subject to wind action; and the clay which covers various parts of the cave-floors.

The Lower Severn Valley.—In a paper entitled "The Lower Severn Valley, River, and Estuary, from the Warwickshire Avon to the Bristol Avon"

(*Proceedings of the Cotteswold Field Club*, vol. 16, part iii., 1909, pp. 241–263) Mr. T. S. Ellis maintains the view that a river system is developed from a network of streams existing before the formation of any principal river-channel, and not, as has been commonly accepted, by the working backward of a small stream starting often from a strong tidal estuary, and capturing the waters of other streams along the backward course. In the case of the Severn, the formation of the main channel has been greatly assisted by the occurrence of an extended anticlinal axis giving access to the sea, and, like other such uplifted rock formations, affording a line more broken and easily denuded than any other line. The anticlinal axis along which the Lower Severn flows is complete in the lower part of its course, and lies between the coalfields of the Forest of Dean and of Bristol lower down the valley, and between the Malvern hills and the Oolitic escarpment higher up. Mr. Ellis draws attention to the fact that the Severn and Avon join at Tewkesbury in the form of a capital Y, and points out in this connection that tributaries generally come in on the convex side of river curves. The influence of tributaries in promoting the formation of river curves is also discussed, and its importance insisted on.

On the Immigration of "Biddulphia Sinensis," Grev., and its Occurrence in the North Sea during 1900–1907.*—In an interesting communication by C. H. Ostenfeld on the diatom *Biddulphia*, an attempt has been made to use the genus as a means of current study. This genus has many species, something like seventy having been noted. Except in the case of a few species, the pustules are thick and highly sculptured, and their weight prevents their occurrence as floating plankton. Prior to the year 1903, it seems, *Biddulphia sinensis* was nowhere to be found in the North sea, but in the November of that year it made its appearance in Danish, Swedish, and German waters. This sudden appearance of *B. sinensis* in waters in which hitherto it had never been observed, and in which, owing to its size, it would have at once been noted, Mr. Ostenfeld attributes to man's agency, *i.e.* it must have been brought either in the bilge water or attached to the outside of some vessel. It has certainly come to stay, and occurs in great profusion in the late autumn, especially off the Belgian coast, which it seems to have made its centre. Owing to its ready adaptability to variations in temperature and salinity of the water, Mr. Ostenfeld considers it a useful means of studying the movements of ocean currents. Many interesting tables of temperature and salinity are given in this paper, with corresponding frequency columns for *B. sinensis*.

Cave Explorations and the Flow of Underground Water.—The indefatigable cave explorer, Mr. E. A. Martel, conducted a subterranean campaign last year on the northern slopes of the Pyrenees, in fulfilment of a commission entrusted to him by the French Minister of Agriculture (*La Géographie*, August, 1909, p. 118). It is recognized that a more perfect knowledge of the underground *regime* of the water in these much-fissured limestone regions is of great practical importance from the point of view of agriculture and water-supply generally, and since completing his last year's work M. Martel has been entrusted with a permanent commission to extend and systematize the knowledge of these phenomena. The recent explorations were concerned with a number of localities in the departments of Haute Garonne, Hautes and Basses Pyrénées, and many additions were made to existing knowledge. Much work was done in the picturesque mountain district of Soule near the Spanish frontier, the gorges of which are among the most striking natural features in France. The underground circulation in the whole region is most

* 'Meddelelser Fra Kommissionen For Havundersogelser.' Series: Plankton Bind, 1 Nr. 6. 1908.

complicated and often upsets the most judicious calculations. But the study proved once more the progressive desiccation of the limestone area and the fall of the water-level. It also showed the complete independence of many neighbouring underground streams and the absence of continuous water-strata for considerable distances. Somewhat analogous though more restricted studies carried out by M. d'Andrimont in the neighbourhood of Marche in Belgium are described by him in the *Bulletin* of the Belgian Geological Society, vol. **22**, fasc. ii. There is there a series of engulfments and reappearances of streams, and the writer referred to undertook experiments, by means of fluorescein, to discover the lines of flow followed underground. They were found to be often quite independent of the slope of the surface, and to be in opposite directions at different levels. The rapidity of flow was greater during low than at high water. M. d'Andrimont holds that it is not necessary to forbid the use for domestic purposes of all water derived from limestone formations, some of these supplying, in his view, a quite adequate means of filtration. Another interesting piece of underground exploration was effected last summer in the Karst region of the Austrian Coastland, where the underground course of a small river near St. Kanzian was for the first time traced to its termination by a party consisting of Lieut. Mühlhofer, Herr Bock, and others. The entrance to the cavern is not far from the spot where the Reka is engulfed, and it had been thought probable that the courses of the two streams might unite beneath the surface. The exploration did not definitely settle the question, for after falling by a very steep gradient through a comparatively small horizontal distance, the stream ended in an underground lake discharged by siphon action, at a level below that of the lowest known underground lake of the Reka. The facts elicited are, however, of interest in connection with the disputed question of the mode of origin and manner of flow of such underground water-systems. It has been denied by some that true underground rivers exist, the observed phenomena being attributed rather to the sucking action of the stream issuing from a cavern on the general mass of the ground-water. This is not, however, consistent with all the facts brought to light in the region in question.

ASIA.

American Ascent of Mount Morrison, Formosa.—Although the ascent of this fine mountain, the highest summit of the Japanese Empire, has been several times effected by Japanese parties since the acquisition of the island by Japan (see, *e.g.*, *Journal*, vol. **11**, p. 68; vol. **33**, p. 497), it had until quite recently been only once ascended by any representative of the white races, while of this ascent, that of Herr Steibel in 1898, no description is available. The *Journal of the North China Branch of the Royal Asiatic Society* (vol. **40**, 1909) contains an account by Mr. J. H. Arnold of an ascent made by him in company with his wife and three gentlemen (Messrs. Hall, Mather, and Stark)—in what year is nowhere stated in the paper itself, and it is only from the somewhat roughly drawn (though detailed) map of the neighbourhood of the mountain, that we learn that it was in 1907, as also that the party was American. The outward route ascended from Toroku (some distance inland from the middle of the west coast) by the valley of the Tanuran, passing through districts inhabited by various aboriginal tribes belonging to the Tsou and Vonuum groups, the former dwelling chiefly on the west, the latter on the east side of the Tanuran. These savages had from time immemorial practised head-hunting until, within recent years, the Japanese commenced the task of their peaceful subjugation. But though some head-hunting still goes on, the writer bears warm testimony to the excellent results already obtained. During the latter part of the ascent of the Tanuran and its upper branches (this river flows almost due north from Mount Morrison) it was necessary to use these savages as baggage-carriers, Mrs.

Arnold, too, being carried the last part of the way on a native carrying-board, attached to the back of a village headman. The Tanuran flows down a gorge shut in by steep-sided mountains, and the trail afforded by no means easy going. Some of the ravines and sheltered spots were forested with oaks and the coniferous *Chamæcyperis* (? *Thuya*) *Formosanus*, while the steep exposed slopes were covered with grass, with azaleas and chrysanthemums. On Mount Morrison itself, some pines and junipers approach the summit, presenting a very torn appearance. At 11,700 feet (an hour's climb from the top) a sweet-water spring was discovered, though previous parties have met with difficulties on the score of water supply. A splendid view was obtained from the summit, both over the nearer sea of mountains and over the ocean to the east and west of the island. The return journey was made in a westerly direction, through the forest-clad region of Mount Ari, where a company was found to be preparing to work a timber concession, being then engaged in carrying a narrow-gauge railway a distance of 40 miles to an elevation of 7000 feet—involving the construction of ninety tunnels. The company had already planted nurseries to provide for the preservation of the forests. The paper contains some interesting descriptions and photographs of the wild tribes met with.

Survey of Ceylon.—An official report by Mr. R. S. Templeton, acting-Surveyor-General, gives a satisfactory account of progress made in 1908 in the survey and settlement of Ceylon. The report is illustrated by two maps, showing roads, cart-tracks, railways, block surveys to date; as also by cuts of block survey areas in different provinces, views of buildings, etc. The topographical preliminary plan issued by the Superintendent of Surveys to the Settlement Officer in 1908 covers 160,000 acres, uninhabited save for twenty-two small claims, totalling less than 900 acres. A surveyor has been appointed to make a survey of all the claimed lands on a larger scale. Block-surveying is now applied to the partition of large areas according to the claims of cultivators. The subdivision of land is further expedited by the numerous surveys required for land sale purposes. The contour survey of 447 square miles completed in 1908 includes some of the most difficult country in Ceylon. Of 1,334,617 acres for which preliminary plans have been issued, 762,346 acres have been settled; the rest are either awaiting or actually under settlement. Fair progress is reported in triangulation. An important event of 1908 was the erection of the new Colombo observatory in the Cinnamon Gardens, its main object being to supply correct mean time to the shipping in the port. To the observatory has been attached a complete meteorological station.

AFRICA.

Dr. Kumm's Journey across the Central Sudan.—Dr. K. Kumm (September number, p. 342) telegraphed to us in October from Wau, in the Bahr-el-Ghazal, announcing his safe arrival there after traversing Bagirmi, Dar Runga, Dar Kuti, and Dar Banda. He has thus successfully achieved his purpose, though apparently by a route somewhat to the south of that originally proposed.

Measurement of the Nile Volume.—Paper No. 7 of the Survey Department, Ministry of Finance, Egypt, is entitled "Measurement of the Volumes Discharged by the Nile during 1905 and 1906," by E. M. Dowson, "with a Note on Rating Formulæ for Current-meters," by J. I. Craig, F.R.S.E. The complicated river-system of the Nile is now fairly well understood. The Nile derives its waters almost exclusively from the rain which falls at different seasons on the two elevated areas of the equatorial and Abyssinian plateaus. The amount of water from the equatorial plateau is relatively small, but is very important for the low-stage condition of the Nile during the spring half of the year (January to June). The rainfall of the Abyssinian plateau forming the Blue Nile furnishes the regular flood

effect upon which the agricultural success of Egypt depends. In the beginning of 1905 it was decided to establish a river gauging station somewhere upstream of the Aswan dam, so as to try and obtain a regular series of determinations of the volumes discharged by the Nile at various seasons. The site chosen was at Sarras, 50 kilometres south of Wadi Halfa. The volume of water delivered by a river at any point along its course at any given time is termed the "discharge" of the river at that point, and is determined according to the following plan: (1) a convenient cross-section, at right angles to the direction of flow, is selected near the desired point; (2) the area of this cross-section is obtained by dividing it up into a number of smaller areas and measuring each of these; (3) an observation, or set of observations, of some sort, is made for each of these smaller areas in turn, by which values are obtained for the average rates of flow of the water through each; (4) the volume discharged through each of these subdivisions respectively is then obtained by multiplying its area by the mean velocity of the water through it, the sum or integration of all these values giving the discharge of the river at the desired point on the day in question. The following was briefly the method adopted to obtain the cross-sectional area, and the average rate of flow through the various component parts of it: a hawser was stretched across the river on the line selected, and soundings were taken at 10-metre intervals along this line, thus dividing the whole section up into a number of smaller ones, and enabling their areas to be calculated on the assumption that each was a trapezium; the mean rate of flow through each of the component sections was next determined by means of a current-meter lowered from the boat into the required position. Details concerning the experimental process together with tables of results are contained in the paper. This set of measurements of the volumes discharged by the river Nile is probably the most reliable yet published, and should be interesting for comparison with the Wadi Halfa gauge records.

Anthropological Research in the Sudan.—Mr. and Mrs. C. G. Seligmann have just left England to initiate anthropological work in the Anglo-Egyptian Sudan. They will be joined later for a few weeks by Mr. Rivers, of Cambridge. The work is to extend over two seasons, and an appropriation has been made by the Sudan Government to meet the expense. In the coming season the plan is to pursue sociological investigation, if possible, in Southern Kordofan, and, if time permits, among the blacks of the White Nile; and also to instruct the local provincial officials in the methods and aims of such investigation, in the hope that a regular system of local anthropological information may be instituted. Many of these officials are now grounded in anthropological method at Oxford and Cambridge before they enter the service. In the second season anthropometric work will be instituted, and it is hoped that a firstrate specialist in that branch may be found to accompany Dr. Seligmann. Great importance is attached to the share to be borne by Mrs. Seligmann, who proved, on her husband's recent expedition to the Veddas of Ceylon, of the utmost service in overcoming the shyness of that secretive people. Should Southern Kordofan be too difficult of access, the chief intensive work will be done among the Shilluks or Dinkas. The plan was originated after a short visit paid to the Sudan in 1907 by Mr. D. G. Hogarth, who put before Mr. James Currie, the Director of Education, the desirability of acquiring further anthropological information about the Sudanese. The idea was taken up warmly by Mr. Currie, and backed by Mr. J. W. Crowfoot, then Assistant-director of Education, who had done anthropological work in the country. The Sirdar at once welcomed the project, showing himself well aware how the government of savage tribes may be facilitated by the acquisition of exact knowledge of their affinities, customs, religions, and the like. It is to his support and that of Mr. Currie that

the realization of this project is due; but many other officials in the Sudan have given valuable preliminary help. Dr. and Mrs. Seligmann hope to return in April.

Captain Cortier's Surveys in the Sahara.—We referred some months ago to the new expedition entrusted to Captain Cortier, known for his journey across the Sahara in 1907. The original intention was that he should cross the desert by a line which would take him to the countries north of Lake Chad, but this plan was modified. In association with Captain Niéger (also known for previous exploratory work in the Sahara), he carried out various surveys in the North Central Sahara (the Tinghert and Tassili plateaus, etc.), and then, having separated from his companion, proceeded towards the Ahaggar by an almost new route. From Ahaggar, in company with Lieut. Sigonney, he set out for Air, his intention being to go first south to Adrar, and thence survey the previously untraversed route from Tin Zawaten to Iferuane, on the borders of Air. According to a letter addressed to the Paris Geographical Society from Agades on March 11, 1909 (*Revue Française*, September, 1909), he had successfully carried out his purpose. Following the course of the Wed Zazir (in which, to his surprise, he found uninterrupted pasturage), he had gone south to the well of Admer, which was reached on January 15. There the travellers separated, Sigonney going to Tin Zawaten, while Cortier took the route for In Gezzam and Iferuane. This involved the crossing of the dreaded "Tanezruft," with ten waterless marches, but, thanks to recent rain, pasturage was met with throughout. Captain Cortier was the first traveller to visit the important watering-place of In Gezzan, on the border of the Tanezruft, the only point between Air, Adrar, the Awellimiden country, and the Ahaggar, at which water can always be found—a fact which makes it the crossing-point of routes from all these regions. Captain Sigonney in turn surveyed the portion of the route between In Gezzam and Tin Zawaten. The most important points between the Ahaggar and Air have been fixed astronomically, though the meteorological conditions were far from favourable.

The Forest Resources of the Kamerun.—During the past year an expert examination of the forests of the Kamerun has been made by an expedition consisting of Drs. Jentsch and Büsgen, assisted by two of the forest officers of the colony (*Deutsches Kolonialblatt*, September 15, 1909). The districts visited included the basin of the Mungo river (where attempts at exploration have already been made near Johann-Albrechtshöhe) and the extreme northern borders of the forest region, in the north of the colony, and a portion of the basin of the Sanaga further south. In each of these specimen plots were measured, and a detailed examination was made of the trees standing in them, which were grouped in categories according to the size of the trunks. On the Mungo secondary forest was the more common type, owing to the progress of settlement in this district, but primary forest was more prevalent in the other two areas visited. Very definite conclusions as to the prospects of forest-exploitation are not yet possible, but the opinion is expressed that it is only the primary forest which would repay systematic attempts at conservation. Special attention was given to the forests composed of a tree spoken of as the "Schirmbaum" (? *Hibiscus tiliaceus*), which is valuable as favouring the return of once cultivated lands to primary forest, no weeds or useless brushwood growing beneath its shade. An interesting fact referred to is the "succession of species" apparently brought about by nature in the tropical forests; that is to say, the species present may be quite unequally represented in the various age-categories, some being found only among the older trees, others only among the younger growths. And while this is the case in one locality, the position may be reversed in another.

AUSTRALASIA AND PACIFIC ISLANDS.

Dutch Exploration in New Guinea.—The activity displayed by the Dutch during recent years in the exploration of their part of New Guinea is being well maintained. During the past two years a military party under Commandant Gooszen and other officers, acting under the general direction of Mr. Hellwig, "Resident" of this part of the Dutch territory, has been at work surveying various rivers which debouch on the south coast, especially the "North" and "North-west" rivers in the neighbourhood of East bay, and a number of streams which enter the sea between Frederick Henry island and the boundary with British territory. Reports of the several expeditions have appeared from time to time in the *Tijdschrift* of the Netherlands Geographical Society, accompanied by maps (see especially vol. **25**, pp. 179, 584, 1179; vol. **26**, pp. 142, 272, 451, 654). On the other hand, Mr. H. A. Lorentz, leader of the expedition which two years ago attempted, with some measure of success, an exploration towards the interior snowy range of this part of New Guinea (*Journal*, vol. **31**, p. 447), has started on a new attempt to reach the snowy range (*Globus*, vol. **90**, p. 259). The expedition has been equipped by two Dutch societies for the promotion of research in the colonies, and has also the support of the Dutch Colonial Office. Besides the leader, Messrs. J. W. van Nouhuijs and van Römer are taking part in the expedition, which left Surabaya for New Guinea on August 15 last.

Boundaries of German New Guinea.—A joint commission for the demarcation of the frontier between British and German New Guinea in the neighbourhood of the Waria river has been at work during the year, and has, we believe, now completed its task. Among other points, the intersection of the 147th degree of East longitude with the 8th of South latitude was carefully determined. On the western side of the German territory, the boundary with Dutch New Guinea (as between the latter and British "Papua") is the 141st degree of East longitude, but as this has not been accurately laid down on the map, negotiations have lately been carried out at the Hague with a view to selecting a definite and easily marked line (*Petermanns Mitteilungen*, 1909, p. 324). As a result, it has been decided to send out two survey expeditions—a German and a Dutch—to determine the question whether the physical features of the neighbourhood of 141° are such as to lend themselves to the tracing of a *natural* boundary-line, and they are to begin work next year. The leader of the German expedition will be Dr. L. Schultze, well known for his scientific researches in German South-West Africa.

French Enterprise in Kerguelen Land.—The July number of *La Géographie* contains the report of a paper by M. Henri Bossière on a voyage made early in the present year to Kerguelen Land, including also a succinct account of the various attempts made by himself and his brother to develop the resources of the group in the direction of sheep-farming, the whale fishery, etc., since the concession of exclusive rights in the islands was granted to them by the French Government some years ago. Unusual determination and energy seem to have been devoted by the brothers to the task in spite of many difficulties and disappointments, and, except from the whale fishery, but small returns seem yet to have been secured. Quite a number of different voyages have been made, either by MM. Bossière themselves or in association with them, including that of M. de Gerlache, the Belgian Antarctic explorer, to which reference has already been made in the *Journal*. During his recent visit, M. Bossière paid considerable attention to the exploration of the interior and an examination of its resources, one result being the discovery of a considerable extension of Royal sound not shown in the best existing maps. The interior consists of rocky plateaus devoid of life, with lakes

discharging to the valleys by high waterfalls. The chief fodder-plant is the *Acæna*, which spreads at the expense of the *Gramineæ*, and which is greedily eaten by horses, sheep, and hogs. Of other plants, the *Azorella celago* and the Kerguelen cabbage both suffer from the ravages of rabbits. Some attempts to introduce sheep have been made, but though lambs have been produced, it has not yet been proved whether they will bear the rigours of winter without shelter. Sea-elephants, which had at one time been almost exterminated, have lately gained ground.

POLAR REGIONS.

The North Polar Controversy.—The National Geographical Society of Washington, which lately appointed a committee to examine and report on Commander Peary's claim to have reached the North Pole, has awarded its gold medal to the explorer. The committee, consisting of Admiral Chester, Mr. O. H. Tittman, Superintendent of the Coast Survey, and Mr. Henry Gannett, Geographer to the U.S. Geological Survey, reported that Commander Peary's documents afforded conclusive proof of the justice of his claim, and this report was unanimously accepted by the board of managers of the society. Another committee has been entrusted with the task of pronouncing whether any explorer reached the North Pole before 1909; in other words, whether Dr. Cook's claim to have done so in 1908 is worthy of credence. It is understood that the society has appealed to the University of Copenhagen to waive its right of priority in the investigation of Dr. Cook's data, and that the university has declined to accede to this request.

MATHEMATICAL AND PHYSICAL GEOGRAPHY.

Magnetic Research of the Carnegie Institution.—The *Carnegie*—the non-magnetic vessel specially built for the above research—was launched on June 12, 1909, and has already begun her first cruise for magnetic work in the North Atlantic. She left Brooklyn on August 21, proceeding first to Gardiner's bay, Long island, and afterwards to St. John's, Newfoundland, whence the Atlantic was crossed to Falmouth, which was reached on October 14. The vessel was then to proceed to Madeira, returning to New York, *viâ* Bermuda, early next year. An account of the *Carnegie*'s non-magnetic gas-engine was given in *Terrestrial Magnetism* for September, while a preliminary statement of the results to date appeared in *Nature* for October 28. The *Carnegie* is under the command of Mr. W. J. Peters, as was the *Galilee* during the similar work in the Pacific (*Journal*, vol. **31**, p. 448); Prof. Bauer having the general control of the operations.

New Oceanographical Research Expedition.—The Norwegian Government has granted to Sir John Murray the use of the steamship *Michael Sars* for the purposes of an oceanographical research expedition in the North Atlantic in the spring of next year. Permission has also been given to Dr. Johan Hjort, the Director of the Norwegian Fisheries, Dr. Helland-Hansen, and Mr. Koefoed (Dr. Hjort's assistant) to take part in the expedition, as well as the ship's captain and crew, all of whom are experienced in deep-sea work. A further member of the expedition will be Prof. Gran. According to the *Times*, the *Michael Sars* will leave Plymouth early in April, and proceed to the Atlantic coast of Morocco, obtaining on the way several series of oceanographical observations extending from the coasts of Europe and Africa over the continental shelf into the deep Atlantic. Madeira and the Azores will be visited, and, should the weather conditions be favourable, the voyage will be continued across the Atlantic to Newfoundland, and thence to Iceland, the Færoes, and Scotland. In the event of unfavourable weather, the expedition will keep near the coast of Europe on the return voyage north. One of the conditions laid down by the Norwegian Government is that the expedition shall not last more

than four months. Apart from the assistance rendered by Norway in lending the ship and the services of Norwegian officials, the expenses of the expedition will be borne by Sir John Murray. Among the problems which will receive special attention are the mode of formation of the deeper layers of the North Atlantic; the distribution in depth of the pelagic algæ and their relation to the depth to which sunlight penetrates in different latitudes; the rate of currents over oceanic shoals and in deep water; and the composition of the oceanic deposits.

GENERAL.

Honours to Explorers.—The list of Birthday Honours published on November 9 was notable, from the geographical point of view, for the inclusion of two successful explorers. Mr. E. H. Shackleton received the honour of knighthood, while Dr. Sven Hedin was appointed an Honorary K.C.I.E.

Map of the World on the Scale of 1 : 1,000,000.—At the invitation of the British Government, the International Committee for the furtherance of the scheme for the above map met in London during the third week in November, the following countries being represented—Australia, Austria-Hungary, Canada, France, Germany, Great Britain, Italy, Spain, and the United States. A report of the proceedings, which followed the lines laid down at the International Geographical Congress last year at Geneva, will appear in a subsequent number of the *Journal*.

OBITUARY.

Robert Needham Cust, LL.D.

The death of Dr. Cust removes a Fellow of nearly forty years' standing, who for several years assisted in the direction of the affairs of the Society as a member of the Council. Born in 1821, the nephew on his father's side of the first Earl Brownlow, and on his mother's side of the second Earl of Kilmorey, he early showed signs of that linguistic ability which was developed in later life to a remarkable degree, and which largely influenced the course of his studies. When he left Haileybury, where he had gone from Eton with a view to taking up an appointment in the Indian Civil Service, he had already acquired a knowledge not only of Latin, Greek, French, German, and Italian, but of Hebrew, Sanscrit, Urdu, Persian, and Arabic. Arrived in India in 1843, having crossed on the outward journey overland from the Mediterranean to the Gulf of Suez, and thence to Calcutta by the first steamer that sailed to that port from Suez, young Cust spent another year in advancing his knowledge of Indian languages, and then proceeded to Ambala as assistant to the Governor-General's agent on the North-West Frontier. The journey was performed in a palanquin, and occupied seven weeks. With intervals of absence on furlough, Mr. Cust remained in India, occupying posts of great and increasing importance in the northern provinces, till 1867, when the death of his wife led him to resign the post he then held as Financial Commissioner for the North-West Provinces and retire from the service. Two years elapsed, and then the passion for travel reasserted itself. Before going out to India, and when on leave of absence, Mr. Cust had toured extensively in Europe. He now resumed the practice, first spending some years in making himself well acquainted with the British Isles, then travelling again on the Continent, in Palestine and other parts of Asiatic Turkey, and in Northern Africa. America and Australia he deliberately left out of his "orbit," on

the ground that "there was nothing ancient or historic to be studied in those regions." Though not an explorer, he gained a wide knowledge of many countries and many peoples. In Europe his tours extended from North Cape to Constantinople, and from Lisbon to Moscow, many of them being undertaken in connection with International Oriental Congresses, in which he took a prominent part. He was elected in 1872 to the Council of the Royal Asiatic Society, became honorary secretary to that society in 1880, and at a later date one of its vice-presidents. Our own Society he joined in 1872, serving on the Council from 1877 to 1881, 1882 to 1886, and 1889 to 1892. Until advancing years necessitated a restriction of his activities, he was a frequent attendant at the evening meetings, at one of which, in 1881, he read a paper, sent to him by Colonel H. C. Tanner, on the tribes of Kafiristan, supplemented by notes of his own. He always made it a practice to study beforehand, both geographically and historically, the country in which he was going to travel, and afterwards to write an account of his tour for some scientific or other journal. Among more extended works his writings include an account of the modern languages of India, for many years the standard work on the subject, and the basis of the researches on which the official Linguistic Survey of India is being constructed; as well as a comprehensive 'Sketch of the Modern Languages of Africa.' In 1886 the University of Edinburgh conferred on him the honorary degree of LL.D.

CORRESPONDENCE.

The Topographical Map of Canada.

In the May number of the *Journal* I note a review by "E. H. H." of some thirteen sheets published by the Department of Militia, and of nine sheets published by the Department of the Interior.

In 1903, Major E. H. Hills, C.M.G.—who by a curious coincidence has exactly the same initials as "E. H. H."—arrived in Ottawa. After interviewing a number of officials, including myself, he departed for British Columbia. After a time he reappeared in Ottawa and re-interviewed a number of us. In due course there appeared a "Report on the Survey of Canada."* The four and a half pages on "Existing Survey Work in Canada" could have been written—without the inaccuracies—by any one conversant with geographical work in Canada, and the remainder by any one conversant with accurate topographic methods. Major Hills, therefore, had every opportunity to learn the exact facts of the case. That he has not done so, must be attributed to constitutional defects. At any rate, I propose to show that most of his statements are absolutely the reverse of correct, and that everything possible has been done to depreciate the "Standard" maps and to appreciate the "Topographic" maps. I also desire to make the strongest possible protest against the publication of this prejudiced attack without giving me a chance to reply—the attack and reply being published simultaneously, thus giving the readers of the *Journal* an opportunity to judge between us. I venture to say that, had this been done, "E. H. H." would have either retracted his review or modified it to such an extent that his article would have been without any *raison d'etre*.

(1) I am of the opinion that Canadians know better than any one else *what* they require and *when* they require it.

* *Vide Geogr. Journ.*, May, 1909, p. 585.

(2) As chief geographer—and as I have had upwards of twenty-five years experience in topographical work in the field and in mapping work in the office, five years as geographer of the Geological Survey, and ten years as geographer of the Department of the Interior—I take it that I am a better judge of what Canada and Canadians require than "E. H. H." is or ever can be.

(3) The nine Standard sheets cover about *twenty* times the area included in the thirteen Topographic sheets, and they have been produced for a fraction of the cost of the latter.

(4) The areas covered by the Topographic sheets are well-settled regions traversed by numerous roads, and include some of the most productive regions of Canada, whereas the areas covered by the Standard sheets include not only areas similar to the foregoing, but also thousands of square miles without a single inhabitant except a few trappers and Indians. To compare maps covering these unsettled areas with sheets including the so-called "Garden of Canada," is, to put it mildly, unfair.

(5) "E. H. H." says that if "each map found its particular sphere of usefulness, we might be inclined to congratulate the Government." That is precisely what has happened and is happening. Each map has "its particular sphere of usefulness," and I have no hesitation in saying that, so far as the development of Canada is concerned, the Interior maps are more valuable, and, assuming that the present rate of production is continued, the mapping of the whole of Southern Canada will be completed in *one-twentieth* of the time that it would take to map it on the larger scale. As a matter of fact, while the former is within measurable reach, the latter will not be completed in the lifetime of any person now living, if ever.

(6) "E. H. H." states that "the Standard map is not based on a triangulation or other accurate fixation of points. . . . The Topographic map is based partly upon a precise triangulation and partly upon accurate traverses."

The foregoing is, in its essence, absolutely untrue. Both maps are based on the triangulation of the U.S. Lake Survey, and on the survey of the north shore of the Lake Erie by Dr. Klotz. For the balance, my maps are based on transit-and-chain traverses made under my direction, and tied to points that have been accurately determined in latitude and longitude by the staff of the chief astronomer; on the transit-and-chain surveys for railways, canals, etc. The Topographic maps are based on exactly the same information, but, owing to the difference in scale (their unit area being sixteen times mine), they have had, perforce, to run more transit lines than I did. "E. H. H." intimates—though he does not say it—that the Militia Department has carried out a "precise triangulation" in the area covered by the thirteen sheets, whereas they have not triangulated a mile in the whole area. Many of the roads in some of my sheets have been filled in with odometer, micrometer, and cyclometer surveys, which, as every one knows, are of a higher degree of accuracy than paced surveys.

(7) The statement that "the natural water features are only approximately sketched in," is one of those half-truths that is difficult to combat. In so far as it applies to all streams and lakes in the well-settled areas and to the principal lakes and streams in the unsettled areas, it is without foundation either in substance or in detail. So far as the comparison is concerned, the streams and lakes on my maps are, at least, as accurately shown as on the Topographic sheets.

(8) That the Standard maps do not show woods and houses is not germane to the subject, inasmuch as the scale, practically 4 miles to 1 inch, would not permit their inclusion.

(9) "E. H. H." objects to what he calls the "black network lines," doubtless referring to the "lot" and "concession" lines of the Ontario and Quebec systems

of land survey. To any one with even a rudimentary knowledge of Canada, this is only amusing. All properties in these provinces are described by lot, concession, and township, and their inclusion forms one of the most valuable features of the maps. His objection to the "series of Arabic and Roman numerals" for numbers of lots and concessions is ludicrous, in view of the fact that the *same numbers appear on the Topographic maps*, though the lot and concession lines do not, which latter—from a Canadian point of view—is a regrettable omission.

(10) "E. H. H." laments the omission of a reference table giving the meanings of the conventional signs used. As there are very few conventional signs used, and as those that are used are signs that are familiar to almost the meanest intelligence, I omitted to add a reference table. Now that "E. H. H." has informed me that there are people on the other side of the Atlantic who cannot understand the commonest map-signs, I will have it inserted in future sheets.

(11) The one partially accurate statement is that the Standard map "contains no representation of the form of the ground, neither contours, hill-shading, nor heights." It does not, for the very good reason that the information was not available at the date of publication; there was no money available for procuring the information, and it was not desirable that the map be delayed pending its receipt. The surveys necessary to procure this information for the six standard sheets would not have been made in seventy-five years nor at a cost of a half-million dollars. In other words, the development of Canada is to be delayed for years, while "E. H. H." and others of that ilk calmly proceed with their surveys. It is only necessary to state the foregoing to show the puerility of his argument. I say "partially accurate," inasmuch as the elevations of the railway stations, principal lakes, etc., are given. In addition, as these maps are engraved on copper, and as new editions will be required from time to time, as fast as the information is available, we will incorporate in them a "representation of the form of the ground."

(12) "E. H. H." omits to mention that the Topographic map is engraved and printed by the War Office, and that the Standard map is engraved and printed in Canada.

Finally, while I cannot quarrel with "E. H. H.'s" opinion that the Standard map is "of small value," particularly as he elsewhere states that it is "such as serves a useful purpose until a proper survey is made," I desire to enter the strongest possible protest against a reviewer making such grossly inaccurate statements respecting the basis of compilation of these sheets. Either he was in a position to make authoritative statements regarding the matter or he was not. If we accept the latter alternative, why were the columns of the *Journal* thrown open to him, and why was this quasi-authority given to his inaccurate and misleading statements, which, I regret to say, I cannot characterize as I desire, and at the same time keep within the bounds of parliamentary language? I have dealt with the subject at considerable length, as it is such an uncalled-for and unjustifiable attack on my work. It is also proper at this juncture to call attention to the fact that, as "E. H. H." well knows, the Geological Survey of Canada has, during the past sixty odd years, issued at least three hundred maps, not one-twentieth of which have differed from mine, so far as the basis of the compilation and material included are concerned. From beginning to end of the article there is not a word about the Geological Survey maps. Why was the Interi r selected for attack?

Respecting the good taste and correctness of "E. H. H.'s" action in utilizing information acquired while on an official mi sion—even assuming that every word of his review were correct—I leave the readers of the *Journal* to judge for themselves.

JAMES WHITE, Chief Geographer.

Mr. White's defence of the maps of Canada issued by the Department of the Interior calls for a reply from me, which I shall endeavour to keep within as short limits as possible.

I regret that the most careful reading of his letter does not show me in what material particulars the facts stated in the original review were "grossly inaccurate" or "misleading." The gist of my criticism can be put in a few words: The Department of the Interior issues a map of Canada entitled the Standard Topographical map. To geographers the words "topographical map" bear a perfectly definite meaning and connote: (1) a map based upon accurate surveys; (2) a map showing all the natural and artificial features as far as is possible on the selected scale. The map in question complies with neither of these tests. It is not based upon accurate surveys in that, according to Mr. White's own description, its framework consists of a triangulation along one edge, traverses between *astronomically* determined points, and railway and canal surveys. It does not show all the features of the ground, in that it contains no representation of ground forms and only partial representation of water features. It is, therefore, not a topographical map in any sense in which the words are generally used.

Whether it can be fairly described as a "Standard" map is at least open to doubt. The term "standard" has no specific connotation in this connection, but it would certainly seem inapplicable to a map which, at all events as regards a portion of its area, is being rapidly superseded.

No one on this side of the Atlantic is concerned to deny the proposition that the Canadians are the best judges of the sort of maps they require. What does appear to us questionable is whether the ultimate interests of the country are really served by the issue, on the part of a Government department, of a map under a delusive title, and whether the mapping of Canada would not advance somewhat more rapidly if an agreement could be made to drop overlapping work and to concentrate all the funds available in the hands of one department. The facts quoted by Mr. White as to the maps produced by the Geological Survey accentuate our doubts as to the wisdom of the present policy.

E. H. H.

"E. H. H." says that a careful reading of my letter does not show that his review was "inaccurate" or "misleading." I will take one paragraph in my reply. (6) "E. H. H." states that "the Standard map is not based on a triangulation or other accurate fixation of points. . . . The Topographic map is based partly upon a precise triangulation and partly upon accurate traverses." If I read correctly "E. H. H.'s" review, he desires to convey certain ideas which may be summarized as follows: (1) That the Standard map is not based on a triangulation. (2) That the Topographic map is based on a triangulation. (3) That the Standard map is not based on accurate traverses; and (4) that the portion of the Topographic map not based upon a precise triangulation is based on accurate traverses.

Now what are the facts: (1) That the same triangulation was used for both maps in the area covered by the Topographic sheets. (2) That both maps depend upon transit-and-chain traverses as a basis, and that 75 per cent. at least of the roads in the area covered by the Topographic sheets are not chained at all.

If "E. H. H." is still convinced that his statements respecting the foregoing are not "inaccurate" and are not "misleading," he is welcome to his opinion.

In his reply, "E. H. H." criticizes my maps on the ground that the "framework consists of a triangulation along one edge," etc., and says, "It is therefore not a topographical map," disingenuously omitting to add the deduction that therefore

the Topographic maps that he has been lauding are not "topographical maps" either. I do not propose to enter into a discussion respecting the name "Standard Topographical." I have adopted it, and propose to adhere to it. As soon as information that will enable me to represent the form of the ground is available, I will add it and publish a new edition.

With his dictum respecting the concentration in one department of all the mapping, I am in thorough agreement, but, if concentrated, I propose that it be concentrated in my branch, and I do not propose to sit quietly while his errors of statement are made the basis of an attack on me and on my work.

JAMES WHITE.

Volcanic Upheaval off the Coast of Burma.

S.s. *Katoria*, B.I.S.N. Co., Ltd.,
Strand Road, Calcutta, October 18, 1909.

On September 30, 1909, whilst on a voyage from Rangoon to Kyank-pyn—a small port on the Arrakan coast of Burma, I observed a remarkable volcanic upheaval in lat. 19° 21¼′ N., long. 93° 22′ E., an account of which, I think, may prove of some interest to you.

The circumstances are as follows. On the afternoon of the day in question I was steaming up the coast at about 11½ knots an hour on a N. by E. course, weather fine, with passing clouds and a light south-westerly wind, when at 5.30 p.m. suddenly there was a disturbance in the water right ahead and about 5 miles distant. The disturbance at first resembled the thick black smoke of a steamer on a distant horizon; this was quickly followed by clouds of steam somewhat resembling a near view of a waterspout in the making, and about 20 seconds later a great upheaval of water and huge black masses of mud, which were so clearly defined at their edges that they resembled enormous masses of rock being thrown up in the air, and at first I believed it to be an entire rocky island being thrown up out of the bed of the ocean. This lasted about two minutes, when it subsided rapidly again. The height to which the upheaval reached was about 200 feet above sea-level, and the length from east to west about 2000 feet. These measurements are very nearly correct, as there was a steamer nearer to the upheaval than I was myself, and as I was able to precisely place the position of the volcano I could judge the dimensions with considerable accuracy. At 5.55 p.m. a second upheaval took place, also lasting about two minutes, and similar to the first one, though somewhat smaller. The depth of water where it was thrown up is about 13 fathoms. After the upheaval the wind dropped to a calm in the vicinity, though after steaming about 8 miles out to sea the light south-west wind set in again. The clearly defined edges of the black masses of mud as distinct from and not mixed with the accompanying water can, I believe, be accounted for by the fact that petroleum exists in more or less quantities about this part of Burma coast, and the mud, probably being oily, would of course remain separate from the water. I may add that I think petroleum gases may have something to do with the occasional submarine upheavals that occur in this part of the world. Had a vessel been over the place of disturbance nothing could have saved her, as the force represented to throw up such a vast mass through about 80 feet of water and 200 feet above into the air must have been tremendous.

I trust that this account may prove acceptable to your valuable Society.

ARTHUR R. W. HANDCOCK, Lieut. R.N.R.,
Commanding British India Mail Steamer *Katoria*.

Human Remains in Rhodesian Ruins.

London, W., November 6.

In your November issue is a letter from Mr. R. N. Hall protesting against a note appearing under my name in *Man*, vol. 9, 41. If the writer had waited until he had had an opportunity to read my note instead of acting on the strength of a four-line notice he would have seen whence the skull described came, and that any question as to its age and interest depended entirely on his own statements in 'The Ancient Ruins of Rhodesia,' which were subsequently quoted by Prof. Keane and others. In that work Mr. Hall states that the remains were found *under* the original floor of the Chum ruins, which, according to him, presented no signs of re-occupation by Kaffirs or Portuguese, either at the time of the Monomotapa or later. He further points out that he finds it easy to say whether such re-occupation has taken place, so that his definite statement to the contrary should be authoritative. As Mr. Hall included the Chum ruins in a list of sites whence undoubted remains of "ancients" have been obtained, he evidently believed in their authenticity up to the date of publication of the second edition of 'The Ancient Ruins of Rhodesia,' and gave no indication that he was unacquainted with the site whence they came, or that he had any doubts as to their dating from the first Zimbabwe period, to which he assigns the ruins. On the contrary, seeing that the long bones showed that the former occupant was of unusual stature, he quotes from the Prophet Isaiah to show that the Sabeans were in his time referred to as "men of stature," which presumably indicates that he connected the former occupant of the ruins with the Sabeans, and the Biblical Seba with the Rhodesian Sabi. Neither in Mr. Hall's book nor elsewhere is there any reference to beads or cotton worked with gold thread being found with these particular remains, which he states were buried under the ruins and preserved by the cement floor. The later dating for which he now argues is derived from evidence from elsewhere, not apparently accepted by him at the time of the publication of 'The Ancient Ruins of Rhodesia.' My statement as to the chronological value of the evidence from these remains was as follows: "Taking all the features into consideration, it may be concluded that these remains are those of negroes of a similar type to those now found in Rhodesia. *If the statement as to the situation in which the bones were found be accepted*, it must be concluded that at the time of the construction of the buildings the negro race had already occupied Rhodesia. While it does not show that the negroes built the present ruins, it is at least important to note that the remains found are not those of more northern peoples."

It will thus be seen that Mr. Hall is entirely responsible for disseminating the statement of the authenticity and antiquity of these remains; if he has since found reason to doubt his information, it only shows the disadvantage of publishing discoveries before verifying the details.

FRANK C. SHRUBSALL.

GEOGRAPHICAL LITERATURE OF THE MONTH.

Additions to the Library.

By EDWARD HEAWOOD, M.A., *Librarian*, R.G.S.

The following abbreviations of nouns and the adjectives derived from them are employed to indicate the source of articles from other publications. Geographical names are as a rule written in full:—

A. = Academy, Academie, Akademie.
Abh. = Abhandlungen.
Ann. = Annals, Annales, Annalen.
B. = Bulletin, Bollettino, Boletim.
Col. = Colonies.
Com. = Commerce.
C.R. = Comptes Rendus.
E. = Erdkunde.
G. = Geography, Géographie, Geografia.
Ges. = Gesellschaft.
I. = Institute, Institution.
Iz. = Izvestiya.
J. = Journal.
Jb. = Jahrbuch.
k.k. = kaiserlich und königlich.
M. = Mitteilungen.
Mag. = Magazine.
Mem. (Mém.) = Memoirs, Mémoires.
Met. (mét.) = Meteorological.
P. = Proceedings.
R. = Royal.
Rev. (Riv.) = Review, Revue, Rivista.
S. = Society, Société, Selskab.
Sc. = Science(s).
Sitzb. = Sitzungsbericht.
T. = Transactions.
Ts. = Tijdschrift, Tidskrift.
V. = Verein.
Verh. = Verhandlungen.
W. = Wissenschaft, and compounds.
Z. = Zeitschrift.
Zap. = Zapiski.

On account of the ambiguity of the words *octavo*, *quarto*, etc., the size of books in the list below is denoted by the length and breadth of the cover in inches to the nearest half inch. The size of the *Journal* is 10 × 6½.

A selection of the works in this list will be noticed elsewhere in the "Journal."

EUROPE.

Alps. **Coolidge.**

Conway and Coolidge's Climbers' Guides. The Bernese Oberland. Vol. 1. From the Gemmi to the Mönchjoch. Part I. A new edition. By W. A. B. Coolidge. London: T. Fisher Unwin, 1909. Size 5 × 3½, pp. xxiv. and 156. *Price* 10*s*. *Presented by the Author.*

France—South. **Calmette and Vidal.**

Le Roussillon. Par Joseph Calmette et Pierre Vidal. (Les Régions de la France, vi.) Paris: L. Cerf, 1909. Size 10 × 6½, pp. 66. *Presented by the Publisher.*

The treatment is almost entirely historical, and only incidentally is the influence of geographical factors alluded to.

Germany—Holstein. **Oldekop.**

Topographie des Herzogtums Holstein. Von Henning Oldekop. 2 vols. Kiel: Lipsius & Tischer, 1908. Size 9½ × 6, pp. (vol. 1) [806]; (vol. 2) [806]. *Portrait.* *Price* 20*m*. *Presented by the Publishers.*

Germany—Schleswig. **Oldekop.**

Topographie des Herzogtums Schleswig. Von Henning Oldekop. Kiel: Lipsius & Tischer, 1906. Size 9½ × 6, pp. [1098]. *Portrait.* *Price* 10*m*. *Presented by the Publishers.*

Mediterranean. **Baedeker.**

Das Mittelmeer. Hafenplätze und Seewege, nebst Madeira, den Kanarischen Inseln, der Küste Marokkos, Algerien und Tunisien. Handbuch für Reisende von Karl Baedeker. Leipzig: K. Baedeker, 1909. Size 6½ × 4, pp. xxxii. and 636. *Maps and Plans.* *Price* 9*m*. *Presented by the Editor.*

Mediterranean—Coast-forms. *Ric. G. Italiana* **16** (1909): 136–147. **Marinelli.**

Sull' azione morfologica delle correnti litorali nel Mediterraneo. Di G. Marinelli.

Mediterranean—Currents. *Ric. G. Italiana* **16** (1909): 169–173. **Marini and others.**

Sulle correnti della costa orientale della Sicilia. Di L. Marini, O. Marinelli e G. Platania.

North Sea—Coast. *Deutsche Rundschau G.* **31** (1909): 411–414. **Schiller-Tietz.**

Die Entstehung der Wattpolder an der Nordseeküste. Von Schiller-Tietz.

Northern Europe—Archæology. **Thümmel.**

Der germanische Tempel. Inaugural-Dissertation . . . Von Albert Thümmel. Halle a. S.: E. Karras, 1909. Size 8½ × 5½, pp. 124. *Sketch-map and Plans.* *Presented by the Author.*

The larger part of the study is concerned with remains in Iceland.

Norway—Fjords. **Vallaux.**

Contribution à l'étude des Fjords et des Chenaux latéraux de Norvège. Par Camille Vallaux. (Extrait des Annales de Géographie, tome xvii., No. 99, 15 mai,

1909.) Paris, 1909. Size 10 × 6½, pp. 205–226. *Sketch-maps. Presented by the Author.* [See November number, p. 568.]

Norway—Language. **Thimm.**

Norwegian self-taught, with phonetic pronunciation. By C. A. Thimm. Fourth edition; revised by P. Th. Hanssen. London: E. Marlborough & Co., 1909. Size 7½ × 5, pp. 128. *Illustration. Price 2s. 6d. Presented by the Publishers.*

Russia—Finland. *Fennia: B.S.G. Finlande* **27** (1907–09): No. 3, pp. 96. **Alfthan.**

Contribution à l'étude du Kymmene. Par Max Alfthan. *Maps, Section, and Diagrams.* [In Swedish; *résumé* in French.]

The Kymmene drains the central part of the lake plateau of Finland.

Russia—Finland—Geology. **Leiviskä.**

Fennia: B.S.G. Finlande **25** (1907): No. 2, pp. 118.

Ueber die Oberflächenbildungen Mittel-Ostbottniens und ihre Entstehung. Von I. Leiviskä. *Maps and Illustrations.*

Russia—Finland—Gravity. **Bonsdorff.**

Fennia: B.S.G. Finlande **27** (1907–09): No. 2, pp. 36.

Détermination relative de la pesanteur à Helsingfors. Par le Dr. Ilmari Bonsdorff.

Russia—Finland—Phytogeography. **Leiviskä.**

Fennia: B.S.G. Finlande **27** (1907–09): No. 1, pp. 210.

Ueber die Vegetation an der Küste des bottnischen Meerbusens zwischen Tornio und Kokkola. Von I. Leiviskä. *Maps and Illustrations.*

Russia—Finland—Relief. **Rosberg.**

Fennia: B.S.G. Finlande **24** (1907–08): No. 4, pp. 38.

Studien über Talbildungen im finnischen Lappland und dessen Umgebungen. I. Das Tal des Tulomjok. Von J. E. Rosberg. *Maps and Illustrations.*

Russia—Livonia—Runö. *Ymer* **29** (1909): 197–217. **Hemmendorff.**

Runö. Af Ernst Hemmendorff. *Illustrations.*

Russia—Podolia. *Abrégé B.S. Hongroise G.* **36** (1908): 97–102. **Loziński.**

Die Uebertiefung der Täler im Gebiete des palæozoischen Horstes von Podolien. Von Walery Ritter von Loziński. *Section and Illustrations.* (*Földrajzi Közlemények* **36** (1908): 196–201.)

Russia—Seismology. *Beiträge Geophysik* **10** (1909): 1–124. **Doss.**

Die historisch beglaubigten Einsturzbeben und seismisch-akustischen Phänomene der russischen Ostseeprovinzen. Von Prof. Dr. Bruno Doss. *Maps.*

Scandinavia—Climatology. **De Geer and Sernander.**

On the evidences of late Quaternary changes of climate in Scandinavia. By Gerard de Geer and Rutger Sernander. (Reprinted from *Geologiska Föreningens i Stockholm Förhandlingar*, December, 1908.) Stockholm, 1909. Size 8½ × 5½, pp. 457–473. *Diagram.*

Servia. *Rev. Française* **34** (1909): 147–157. **Demanche.**

Les Aspirations Serbes. Par Georges Demanche. *Sketch-map.*

Servia. **Kanitz.**

Felix Kanitz. Das Königreich Serbien und das Serbenvolk von der Römerzeit bis zur Gegenwart. II. Band: Land und Bevölkerung. Leipzig: B. Meyer, 1909. Size 11 × 7½, pp. x. and 596. *Sketch-maps and Illustrations. Price* 21*s.*

The first volume appeared in 1904 (*Journal*, vol. **24**, p. 234.)

Spain—Aragon. *Spelunca* **7** (1909): No. 55, pp. 24. **Briet.**

Les Grottes de Bastaras (Haut-Aragon, Espagne). Par Lucien Briet. *Plans and Illustrations.*

United Kingdom. **Webb.**

A systematic geography of the British Isles. By George William Webb. London: Methuen & Co., 1909. Size 7½ × 5, pp. viii. and 94. *Sketch-maps and Diagrams. Price* 1*s. Presented by the Publishers.*

United Kingdom—Mountaineering. **Abraham.**

British mountain climbs. By George D. Abraham. London: Mills & Boon, [1909]. Size 7 × 4½, pp. xvi. and 448. *Illustrations. Price* 7*s.* 6*d. net. Presented by the Publishers.*

United Kingdom—Westmoreland. **Marr.**

Cambridge County Geographies, edited by Dr. F. H. H. Guillemard. Westmoreland. By Dr. J. E. Marr. Cambridge: University Press, 1909. Size 7¼ × 5, pp. x. and 152. *Maps, Illustrations, and Diagrams. Price* 1*s.* 6*d. Presented by the Publishers.*

ASIA.

Asia. **Heaton.**

A scientific geography. Book VI. Asia. By Ellis W. Heaton. London: Ralph, Holland & Co., 1909. Size 7½ × 5, pp. 148. *Sketch-maps and Diagrams. Price* 1*s.* 6*d. net. Presented by the Publishers.*

Chinese Empire—Tibet. **Kawaguchi.**

Three years in Tibet. By the Shramana Ekai Kawaguchi. London, etc.: Theosophical Publishing Society, 1909. Size 9¼ × 6, pp. xvi. and 720. *Map and Illustrations. Price* 16*s. net. Presented by the Publishers.*

The journey to Lhasa of this Japanese pilgrim attracted considerable attention a few years ago.

French Indo-China. *La G., B.S.G. Paris* **19** (1909): 177–190. **Bernard.**

L'exploration de l'Indo-Chine et la délimitation de la frontière franco-siamoise. Par F. Bernard.

Japan. *Fortnightly Rev.* **86** (1909): 93–107. **Stopes.**

An Expedition to the Southern Coal-mines. By Mrs. M. C. Stopes.

The author travelled on behalf of the Royal Society for palæobotanical research, and penetrated into some districts where no European had been before.

Malay Archipelago—Celebes. *Ts. K. Ned. Aardr. Genoots.* **26** (1909): 349–380. **Kruijt.**

Het landschaap Bada in Midden-Celebes. Door Alb. C. Kruijt. *Sketch-map.*

Malay Archipelago—Java. *Ts. K. Ned. Aardr. Genoots.* **26** (1909): 447–451. **Jacobson.**

Beklimming van drie van Java's vulkanen. (De Lindoro, de Merapi en de Tangkoeban Prahoe.) Door Edw. Jacobson. *Illustrations.*

Malay Archipelago—Moluccas. **Jongh.**

Ts. K. Ned. Aardr. Genoots. **26** (1909): 381–397.

Morotai. Door G. J. J. de Jongh. *Map.*

Malay Archipelago—Nias. **Rappard.**

Bijdr. Taal-, Land-, en Volkenk. Ned.-Indie **62** (1909): 477–648.

Het eiland Nias en zijne bewoners. Door Th. C. Rappard. *Map and Illustrations.*

Malay Archipelago—Sumatra. *Deutsche Rundschau G.* **31** (1909): 403–407. **Volz.**

Reiseergebnisse in Nord-Sumatra. Von Prof. Dr. Wilhelm Volz. *Map.*

Malay Archipelago—Sumatra. *Globus* **95** (1909): 1–7, 24–29. **Volz.**

Die Bevölkerung Sumatras. Von Prof. Dr. Wilhelm Volz. *Illustrations.*

Malay Peninsula—Ethnology. **Cerruti.**

My friends the savages: notes and observations of a Perak settler. By Captain G. B. Cerruti. Como: Tipographia Co-operativa, 1908. Size 7¼ × 5, pp. 284. *Illustrations. Presented by the Author.*

Translated from the Italian.

Malay States. ———

Siam. No. 1 (1909): Despatch from His Majesty's Minister in Siam, forwarding a Treaty between Great Britain and Siam, signed at Bangkok, March 10, 1909, together with an explanatory memorandum. London: Wyman & Sons, 1909. Size 13 × 8½, pp. 8. *Map. Price* 7½*d.*

See note in the August number (p. 211).

Persia. **Bradley-Birt.**

Through Persia from the Gulf to the Caspian. By F. B. Bradley-Birt. London: Smith, Elder & Co., 1909. Size 9 × 5½, pp x., and 332. *Map and Illustrations. Price* 12*s.* 6*d. net. Presented by the Publishers.*

Philippines—Historical. **Blair and Robertson.**

The Philippine Islands, 1493–1898. Explorations by early navigators, descriptions of the islands and their peoples, their history and records of the Catholic missions,

as related in contemporaneous books and manuscripts, showing the political, economic, commercial, and religious conditions of those islands from their earliest relations with European nations to the close of the nineteenth century. Translated from the originals. Edited and annotated by Emma Helen Blair and James Alexander Robertson, with historical introduction and additional notes by Edward Gaylord Bourne. Vols. **46–55**, 1721–1898, Bibliography and Index. Cleveland, Ohio: The Arthur H. Clark Co., 1907–1909. Size 9½ × 6½. *Facsimile Maps, Plans, and Illustrations. Price* 16*s.* 8*d. net per vol.*

This important series is now complete.

AFRICA.

Belgian Congo—Phytogeography. **Durand.**

Ministère des Colonies. Sylloge floræ congolanæ (Phanerogamæ). Par Théophile Durand et Hélène Durand. Brussels: A. de Boek, 1909. Size 10½ × 7, pp. 716. *Presented by the Minister of Colonies, Brussels.*

Presents a conspectus of all known species of phanerogams from the Congo down to the end of 1908. The number, which in 1900 only reached 1928, has since mounted to 3546.

Cape Colony—Historical. **Dehérain.**

Henri Dehérain. Etudes sur l'Afrique (second série). Le Cap de Bonne-Espérance au XVIII^e^ siècle. Paris: Hachette & Cie., 1909. Size 7½ × 5, pp. vi. and 256. *Sketch-maps. Price* 3.50 *fr. Presented by the Publishers.*

Egypt. **Weigall.**

Travels in the Upper Egyptian deserts. By Arthur E. P. Weigall. Edinburgh and London: Blackwood & Sons, 1909. Size 9 × 5½, pp. xiv. and 194. *Illustrations. Price* 7*s.* 6*d. net. Presented by the Publishers.*

Egypt—Mining. *Cairo Sc. J.* **3** (1909): 110–119. **Thomas.**

Notes on the Mining Industry of Egypt. From ancient times to 1900. By E. S. Thomas.

Egypt—Census.

Ministry of Finance. Egypt. The Census of Egypt, taken in 1907 under the direction of C. C. Lowis. Cairo, 1909. Size 13½ × 8½, pp. xviii. and 488. *Sketch-maps. Presented by the Director-General.*

Egypt—Population. *Cairo Sc. J.* **3** (1909): 51–63. **Smith.**

The People of Egypt. The Presidential Address of the Cairo Scientific Society. By G. Elliot Smith.

Egypt—Survey. **Lyons.**

Ministry of Finance, Egypt. Survey Department. A comparison of the Cadastral Survey of Egypt, with those of some European Countries. By Captain H. G. Lyons. Cairo, 1909. Size 10½ × 7½, pp. 24. *Plans.*

Egyptian Sudan.

Sudan. Report for the year 1908 on the Trade of Port Sudan. (Diplomatic and Consular Reports, Annual Series, No. 4193, 1909.) Size 9½ × 6, pp. 8.

The completion of the quays in 1909 is thought likely to be followed by a large increase in the shipping.

Egyptian Sudan—Wells. *Geol. Mag.* **V. 6** (1909): 265–271, 311–318. **Grabham.**

Wells of the North-Eastern Sudan. By G. W. Grabham. *Sketch-maps*

Eritrea—Climate. *Riv. G. Italiana* **16** (1909): 185–208. **Danielli and Marinelli.**

Le regione climatiche della Colonia Eritrea. Di G. Dainelli e O. Marinelli. *Sketch-map.*

French Congo. *B.S.G. Alger* **13** (1908): 222–235. **Pouperon.**

Deuxième Mission de P. Pouperon dans la Sangha. (Août—Septembre 1907.) Par Paul Pouperon.

French West Africa. *B.S. Languedoc. G.* **32** (1909): 25–68. **Viala.**

Exploration en Haute-Guinée (Afrique Occidentale). Par L. Fernand Viala.

French West Africa—Railways. *B.S.G. Com. Paris* **31** (1909): 47–63. **Salesses.**

Les chemins de fer de l'Afrique Occidentale Française. Par Salesses. *Sketch-map.*

German East Africa. *Z. Kolonialpolitik* **11** (1909): 196–206. **Keysselitz and Mayer.**

Allgemeiner Bericht über die Expedition der Hamburgischen Wissenschaftlichen Stiftung nach Deutsch-Ostafrika 1907–1908. Von Dr. Gustav Keysselitz und Dr. Martin Mayer.

The expedition was sent out to study disease-parasites.

German East Africa—Resources. **Stuhlmann.**

Beiträge zur Kulturgeschichte von Ostafrika. Allgemeine Betrachtungen und Studien über die Einführung und wirtschaftliches Bedeutung der Nutzpflanzen und Haustiere mit besondere Berücksichtigung von Deutsch-Ostafrika. Von Dr. Franz Stuhlmann. (Deutsch-Ost-Afrika. . . . Band x.) Berlin: D. Reimer, 1909. Size 11 × 7½, pp. xxiv. and 908. *Sketch-maps and Illustrations. Price* 95*m.*

Portuguese East Africa. *La G., B.S.G. Paris* **19** (1909): 191–206. **Vasse**

Trois années en mission dans le Mozambique. Par Guillaume Vasse.

South Africa—Historical. **Colvin.**

South Africa. By Ian D. Colvin. ("Romance of Empire" Series.) London: T. C. & E. C. Jack, 1909. Size 8½ × 6, pp. xiv. and 328. *Sketch-map and Illustrations. Price* 6*s. net. Presented by the Publishers.*

South Africa—Magnetism. **Beattie.**

Report of a magnetic survey of South Africa. By J. C. Beattie, D.Sc. London (for the Royal Society): The Cambridge University Press, 1909. Size 12 × 9½, pp. x. and 236. *Maps. Price* 20*s. net. Presented by the Royal Society and the Governments of the South African Colonies.*

NORTH AMERICA.

Mexico—Historical. **Díaz del Castillo and others.**

The true history of the conquest of New Spain. By Bernal Díaz del Castillo, one of its conquerors. Edited and published in Mexico by Genaro García. Translated into English, with Introduction and Notes, by Alfred Percival Maudslay [vol. 1]. (Works issued by the Hakluyt Society, Second Series, No. 23.) London, 1908. Size 9 × 5½, pp. lxvi. and 396. *Maps, Plans, and Illustrations. Presented by the Hakluyt Society.*

In this fine edition (to be completed in four or five vols.), the English reader will be presented for the first time with a trustworthy version of this famous history. A correct version of the Spanish text has only lately been published in Mexico.

North America. **Wright.**

The grizzly bear. The narrative of a hunter-naturalist; historical, scientific, and adventurous. By William H. Wright. London: T. Werner Laurie, 1909. Size 8½ × 5½, pp. x. and 274. *Illustrations. Price* 7*s.* 6*d. net. Presented by the Publisher.*

United States—Adirondacks. *American J. Sc.* **27** (1909): 289–298. **Miller.**

Ice-movement and Erosion along the South-Western Adirondacks. By William J. Miller. *Sketch-map and Section.*

United States—Arizona. *J. Geology* **17** (1909): 136–163. **Tolman.**

Erosion and Deposition in the Southern Arizona Bolson Region. By C. F. Tolman. *Diagrams.*

United States—California. *Deutsche Rundschau G.* **31** (1909): 193–205. **Crola.**

Der Salton-See und das Mündungsgebiet des Coloradostromes. Von Otto Crola. *Map and Illustrations.*

United States—California. **Mendenhall.**

U.S. Geol. Surv., Water Supply Paper **225** (1909): pp. 56.

Ground waters of the Indio Region, California, with a sketch of the Colorado Desert. By Walter C. Mendenhall. *Sketch-maps, Sections, and Illustrations.*

United States—California.

California Resources and Possibilities. Nineteenth Annual Report of the California State Board of Trade for the year 1908. Submitted March 10, 1909. San Francisco, 1909. Size 10 × 7, pp. 74. *Map and Illustrations.*

United States—Colorado. **Spurr and others.**

U.S. Geol. Surv., Prof. Paper **63** (1908): pp. 422.

Economic Geology of the Georgetown Quadrangle (together with the Empire

District), Colorado. By Josiah E. Spurr and George H. Garrey, with General Geology by Sydney H. Ball. *Maps, Plans, Sections, and Illustrations.*

United States—Colorado and Utah. *U.S. Geol. Surv. B.* **371** (1909): pp. 52. **Richardson.**
Reconnaissance of the Book Cliffs Coalfield between Grand River, Colorado, and Sunnyside, Utah. By G. B. Richardson. *Sketch-maps, Sections, and Illustrations.*

United States—Communications. *Popular Sc. Monthly* **74** (1909): 141–152. **Fleming.**
Jefferson Davis's camel experiment. By Prof. Walter L. Fleming.
On an attempt to introduce camel transport across the arid region of the United States.

United States—District of Columbia. *National G. Mag.* **20** (1909): 356–359. **Shuster.**
The Original Boundary Stones of the District of Columbia. By Ernest A. Shuster. *Sketch-map.*

United States—Georgia. *Popular Sc. Monthly* **74** (1909): 596–614. **Harper.**
Okefinokee Swamp. By Roland M. Harper. *Sketch-map, Portrait, and Illustrations.*

United States—Glacial Forms. *U.S. Geol. Surv., Prof. Paper* **61** (1909): pp. 96. **Atwood.**
Glaciation of the Uinta and Wasatch Mountains. By Wallace W. Atwood. *Sketch-maps, Diagrams, Sections, and Illustrations.*

United States—Levelling. **Hayford and Pike.**
Department of Commerce and Labour. Coast and Geodetic Survey. Precise Levelling in the United States, 1903–1907, with a Readjustment of the Level Net and Resulting Elevations. By John F. Hayford and L. Pike. Washington, 1909. Size 11½ × 9, pp. 280. *Sketch-map.*

United States—Mississippi. **Merrick.**
Old times on the upper Mississippi: the recollections of a steamboat pilot from 1854 to 1863. By George Byron Merrick. Cleveland, Ohio. The A. H. Clark Co., 1909. Size 9½ × 6½, pp. 324. *Map and Illustrations. Price* $3.

CENTRAL AND SOUTH AMERICA.

Dutch Guiana—Gold. **Middelberg.**
Geologische en technische aanteekeningen over de goudindustrie in Suriname. Door E. Middelberg. Uitgegeven op last van den Gouverneur van Suriname. Amsterdam: J. H. de Bussy. 1908. Size 12½ × 9½, pp. 132. *Map and Illustrations. Presented.*

Peru. **Moss.**
A trip into the interior of Peru. By A. Miles Moss. Lima: [Published by J. Newton], 1909. Size 8 × 11½, pp. 44. *Map and Illustration. Price* 5*s. net. Presented by the Author.*

South America. **Keane and Markham.**
Stanford's Compendium of Geography and Travel (New Issue). Central and South America. Vol. 1. By Dr. A. H. Keane, edited by Sir Clements R. Markham. London: E. Stanford, 1909. Size 8 × 5, pp. xxvi. and 612. *Maps and Illustrations. Price* 15*s. Presented by the Publisher.*

AUSTRALASIA AND PACIFIC ISLANDS.

New Zealand. **Douglas.**
The Dominion of New Zealand. By Sir Arthur P. Douglas. ("The All-Red Series.") London: Sir I. Pitman & Sons, 1909. Size 8½ × 5½, pp. xx. and 444. *Map and Illustrations. Price* 7*s.* 6*d. net. Presented by the Publishers.*

POLAR REGIONS.

Arctic—Meteorology. **Gerlache.**
(Duc d'Orléans. Campagne arctique de 1907.) Tableaux météorologiques, extraits du journal de bord par le Commdt. de Gerlache. [Brussels, 1909.] Size 12½ × 9½, pp. 40.
Extracted from the work reviewed in vol. **33**, p. 708.

Arctic—North Pole.
Peary contre Cook: à qui le Pôle Nord? Paris: Nilsson, [1909]. Size 8½ × 5½, pp. 128. *Price* 1 *fr.* 25.

Greenland—Eskimo. **Amdrup.**

The former Eskimo settlements on the East coast of Greenland between Scoresby and the Angmagsalik District. By G. Amdrup. (Reprinted from *Meddelelser om Grönland*, vol. **28**.) Copenhagen, 1909. Size 9 × 6, pp. 287–328. *Plans and Illustrations. Presented by the Author.*

Noticed in the October number, p. 459.

Greenland Sea. *Scottish G. Mag.* **25** (1909): 281–291. **Mossman.**

The Greenland Sea, its Summer Climate and Ice Distribution. By R. C. Mossman. *Sketch-map, Diagram, and Illustrations.*

Noticed in the Monthly Record, September, p. 346.

Spitsbergen. *Deutsche Rundschau G.* **31** (1909): 218–220. **Andersson.**

Die rechtlichen Verhältnisse aus Spitzbergen. Von Prof. J. G. Andersson.

The recent progress of mining, etc., in Spitsbergen has brought to the front the question of international rights in the group.

Spitsbergen. *Questions Diplomatiques* **27** (1909): 815–819. **Bernardini.**

La question du Spitzberg. Les intérêts de la science devant la conférence internationale. Par L. Bernardini.

Refers to the conference proposed by the Norwegian Government to consider the political status of Spitsbergen, but twice given up.

PHYSICAL AND BIOLOGICAL GEOGRAPHY.

Climatology. **Arctowski.**

L'enchaînement des variations climatiques. Par Henryk Arctowski. Brussels: Société Belge d'Astronomie, 1909. Size 9½ × 6¼, pp. 136. *Sketch-maps and Diagrams. Presented by the Author.*

Geomorphology. **Salisbury.**

Physiography for schools. By Rollin D. Salisbury. London: J. Murray, 1909. Size 8 × 5½, pp. vi. and 532. *Maps, Illustrations, and Diagrams. Price 6s. net. Presented by the Publisher.*

Oceanography—Arctic Ocean. **Orléans.**

Duc d'Orléans. Croisière océanographique accomplie à bord de la Belgica dans la Mer du Grönland, 1905. [Résultats scientifiques.] Brussels: Impr. C. Bulens, 1907. Size 14 × 10½, pp. 568 and vi. *Maps and Illustrations. Price* 100 *fr. Presented by the Duke of Orleans.*

Oceanography—North Atlantic. **Helland-Hansen and Nansen.**

The Norwegian Sea: its physical oceanography. Based upon the Norwegian researches, 1900-1904. By Björn Helland-Hansen and Fridtjof Nansen. (Report on Norwegian Fishery and Marine Investigations, vol. **2**, 1909, No. 9.) Christiania, 1909. Size 10½ × 7½, pp. xx., 390, and xii. *Charts and Sections. Presented by Dr. Nansen.*

Oceanography—North Sea. ———

North Sea Fisheries Investigation Committee. Third Report (Northern Area) on Fishery and Hydrographical Investigations in the North Sea and Adjacent Waters, 1904–06. Statistical Papers. London: Wyman & Sons, 1908. Size 13 × 8½, pp. vi. and 296. *Charts and Diagrams. Price 6s. 8d.*

Deals entirely with Aberdeen trawling operations.

Oceanography—Plankton. **Nathansohn.**

B.I. Océanogr. Monaco, No. 140 (1909): pp. 90.

Sur les relations qui existent entre les changements du plankton végétal et les phénomènes hydrographiques, d'après les recherches faites à bord de l'*Eider*, au large de Monaco, en 1907–1908. Par Alexander Nathansohn.

Oceanography—Sea-level. *Scottish G. Mag.* **25** (1909): 311–324. **Gregory.**

The Level of the Sea. By Prof. J. W. Gregory.

Oceanography—South Pacific. *Ann. Hydrographie* **37** (1909): 51–57. **Nippe.**

Wind- und Stromverhältnisse auf der Fahrt S.M.S. *Planet* von Sydney über Brisbane nach Simpsonhafen und im St. Georgs-Kanal (Bismarck-Archipel) im Juni und September 1908. Nach dem Bericht des Kommandant Nippe. Lotungen S.M.S. *Planet* im Südwestlichen Stillen Ozean. *Charts.*

Oceanography—Voyage of the "Planet." **Brennecke.**

Forschungsreise S.M.S. *Planet* 1906–07; herausgegeben van Reichs-Marine-Amt. III. Band (Kapitel I.–V.): Ozeanographie, von Dr. Brennecke. Berlin, 1909. Size 12 × 9, pp. x. and 1–134. *Maps, Diagrams, and Illustrations. Presented by the Author.*

ANTHROPOGEOGRAPHY AND HISTORICAL GEOGRAPHY.

Anthropogeography—Ships. **Chatterton.**

Sailing ships: the story of their development from the earliest times to the present day. By E. Keble Chatterton. London: Sidgwick & Jackson, 1909. Size 10 × 7, pp. xxii. and 362. *Illustrations. Price* 16*s. net. Presented by the Publishers.*

Historical—Early Voyage. **May and Muller.**

De reis van Jan Cornelisz. May naar de Ijszee en de Amerikaanische kust, 1611–1612. Verzameling van beschieden, uitgegeven door S. Muller. (Werken uitgegeven door de Linschoten-Vereeniging, I.) The Hague: M. Nijhoff, 1909. Size 10 × 6½, pp. lvi. and 226. *Maps. Presented by the Linschoten Society.*

BIOGRAPHY.

Claudius Clavus. **Björnbo and Petersen.**

Der Däne Claudius Clausson Swart (Claudius Clavus), der älteste Kartograph des Nordens, der erste Ptolomäus-Epigon der Renaissance. Eine Monographie von Axel Anthon Björnbo und Carl S. Petersen. Neue Bearbeitung . . . übersetzt von Ella Leser. Innsbruck: Wagner'schen Buchhandlung, 1909. Size 11½ × 9, pp. viii. and 266. *Facsimile-maps. Price* 24*m. Presented by the Publishers.* [To be reviewed.]

Hudson. **Janvier.**

Henry Hudson: A brief statement of his aims and his achievements. By Thomas A. Janvier. To which is added a newly discovered partial record, now first published, of the trial of the mutineers by whom he and others were abandoned to their death. New York and London: Harper & Bros., 1909. Size 7 × 4½, pp. xiv. and 148. *Facsimile maps and Illustrations. Price* 3*s.* 6*d. net. Presented by the Publishers.*

Hudson. **Murphy and Nijhoff.**

Henry Hudson in Holland: An inquiry into the origin and objects of the voyage which led to the discovery of the Hudson River, with bibliographical notes. By Hen. C. Murphy. Reprinted, with notes, documents, and a bibliography, by Wouter Nijhoff. The Hague: M. Nijhoff, 1909. Size 10 × 6½, pp. xii. and 150. *Price* 5 *fl. Presented by the Publisher.*

All the original documents are here reproduced, which was not done in the first edition.

Melladew. **Melladew.**

Sport and travel papers. By H. Melladew. London: T. Fisher Unwin (for private circulation), 1909. Size 9 × 5½, pp. xii. and 336. *Presented by Colonel Melladew.*

Shaler. **Shaler.**

The autobiography of Nathaniel Southgate Shaler, with a supplementary memoir by his wife. Boston, etc.: Houghton Mifflin Co.: [London: A. Constable & Co.], 1909. Size 9½ × 6½, pp. x. and 482. *Portraits and Illustrations. Price* 16*s. net. Presented by the Publishers.*

A short obituary notice of this well-known American geologist, who died in 1906, appeared in vol. **28**, p. 188.

GENERAL.

Education—Text-book. **Cousins.**

A modern geography for Irish Intermediate Schools. By James H. Cousins. Dublin: Maunsel & Co., 1909. Size 7 × 5, pp. xiv. and 158. *Sketch-maps and Diagrams. Price* 1*s.* 6*d. Presented by the Author*

Education—Text-book. **L'Estrange.**

A junior course of comparative geography, consisting of Course A of 'A progressive course of comparative geography.' By P. H. L'Estrange. New Edition. (Pp. viii. and 384.) *Also separate copy of* Part V.: Central and South America and Africa (pp. iv. and 265–320). London: G. Philip & Son, 1909. Size 8½ × 5½. *Maps, Illustrations, and Diagrams. Price* 3*s.* 6*d. net.* (*Part V. only,* 10*d. net.*) *Presented by the Publishers.*

The original work was reviewed in vol. **29**, p. 563. The present edition has been revised and somewhat enlarged.

Egypt and Western Asia. **King and Hall.**

Egypt and Western Asia in the light of recent discoveries. By L. W. King and H. R. Hall. London: Society for Promoting Christian Knowledge, 1907. Size 10 × 7, pp. 480. *Illustrations. Price* 7*s.* 6*d. net.*

Leeches as Parasites. **Masterman.**

Hirudinea as human parasites in Palestine. By E. W. G. Masterman. (From *Parasitology*, vol. 1, No. 2, June, 1908.) London, 1908. Size 10 × 7, pp. 181–184.

The best method of removing a leech that has attached itself to the throat has proved to be the application of a strong solution of cocaine.

Place-names. **Taylor.**

Words and places; or etymological illustrations of history, ethnology, and geography. By the Rev. Isaac Taylor. Edited by Dr. A. Smythe-Palmer. London: G. Routledge & Sons, [1909]. Size 8 × 5, pp. xxxviii. and 426. *Maps. Price* 6*s. Presented by the Publishers.*

This new edition embodies some corrections.

NEW MAPS.

By E. A. REEVES, *Map Curator*, R.G.S.

EUROPE.

British Isles—England and Wales. **Ordnance Survey.**

Sheets published by the Director-General of the Ordnance Survey, Southampton, from October 1 to 30, 1909.

1-inch:—

Large-sheet Series, printed in colours, folded in covers or flat in sheets, 115. *Price, on paper,* 1*s.* 6*d.*; *mounted on linen,* 2*s.*; *mounted in sections,* 2*s.* 6*d.*

6-inch—County Maps:—

Hampshire, 1 sheet. **Kent**, 5 sheets. **Lancashire**, 4 sheets. **Yorkshire**, 6 sheets. 1*s. each.*

1 : 2500 Scale—County Maps:—

Cheshire, 36 sheets. **Hampshire**, 47 sheets. **Kent**, 5 sheets. **Lancashire**, 22 sheets. **Sussex**, 34 sheets. **Yorkshire**, 76 sheets.

E. Stanford, London Agent.

Europe. **International Geological Commission.**

Carte géologique internationale de l'Europe. Scale 1 : 1,500,000 or 1 inch to 23·7 stat. miles. Livraison VI. Berlin: Dietrich Reimer, 1909. *Presented through the Royal Society, London.*

This part contains sheets 12 (E II.), 13 (F II.), 20 (F III.), which include north-east Russia and the districts adjacent to the White sea.

France. **Ministre de l'Intérieur, Paris.**

Carte de la France dressée par ordre du Ministre de l'Intérieur. Scale 1 : 100,000 or 1 inch to 1·6 stat. mile. **Sheets:** xiii.–28, Périgueux; xiii.–32, Agen; xv.–19, Romorantin; xvi.–22, La Châtre; xx.–14, Arcis-sur-Aube; xxii.–23, Mâcon (est); xxii.–29, Valence; xxiii.–24, Nantua. **Paris:** Hachette & Cie., 1909. *Price* 0·80 *fr. each sheet.*

These are new editions.

Italy. **Istituto Italiano d'Arti Grafiche, Bergamo.**

Carta d'Italia speciale per Automobilisti, Ciclisti e Touristi. Scale 1 : 250,000 or 1 inch to 3·9 stat. miles. Sheets: 1, Ginevra; 2, Bellinzona; 3, Trento; 4, Udine; 5, Torino; 6, Milano; 7, Verona; 8, Venezia; 9, Cuneo; 10, Genova; 11, Bologna; 12, Ravenna; 13, Nizza; 14, Firenze; 15, Ancona; 16, Grosseto; 17, Aquila; 18, Chieti; 19, Roma; 20, Foggia; 21, Monte St. Angelo; 23, Napoli; 24, Bari; 25, Lecce; 27, Vallo della Lucania; 28, Castrovillari; 30, Catanzaro; 33, Reggio. Bergamo: Istituto Italiano d'Arti Grafiche, [1909]. *Price* 1 *lire each sheet.*

Shows roads clearly, distances between places in figures, and other information of special importance to automobilists. The sheets are folded for the pocket, and each is accompanied by a useful index to place-names.

Mediterranean. **Survey Department, Cairo.**

School map of the Mediterranean Coasts. [In Arabic.] Scale : 3,000,000 or 1 inch to 47·3 stat. miles. 2 sheets. Cairo: Survey Department, 1909. *Presented by the Director-General, Survey Department, Cairo.*

Another of the series of maps specially designed for Egyptian schools which has lately been noticed by the *Geographical Journal*. It is generally similar in style to those previously published.

Russia. **Bludau and Herkt.**

Flemmings Namentreue (idionomatographische) Länderkarten herausgegeben von Prof. Dr. A. Bludau und Otto Herkt. Blatt 1. Russland. Scale 1 : 4,500,000 or 1 inch to 71·02 stat. miles. Berlin and Glogau: Carl Flemming, [1909]. *Presented by the Publisher.*

A general coloured map of Russia in Europe on an equal-area projection, taken from the Sohr-Berghaus Atlas. It is a well-drawn map, but somewhat overcrowded with names. In fact, to show properly all the detail here attempted, and the number of names given, a much larger scale was required. In the spelling of the names an attempt has been made to adhere strictly to the nomenclature of each country, except that in every case roman letters are used.

Russia. **Gerhardt.**

Karte der russischen Eisenbahnen. Auf Grund des Sborniks der Stations-Entfernungen für die russischen Bahnen entworfen von W. Gerhardt. 1 Auflage. Scale 1 : 2,500,000 or 1 inch to 39·4 stat. miles. 4 sheets. Berlin and Glogau: Carl Flemming, [1909].

For all interested in Russian railways this map will be found to contain much valuable and reliable information. By means of symbols and colours all the various lines are clearly distinguished. The map is published by permission of the Royal Russian Ministry of Public Works.

ASIA.

Indo-China. **Cupet, Friquegnon, De Malglaive and Seauve.**

Indo-Chine. Carte de la Mission Pavie dressée sous les auspices du Ministre des Affaires Étrangères et du Ministre des Colonies sous le direction de M. Pavie par MM. les Capitaines Cupet, Friquegnon, De Malglaive et Seauve. Scale 1 : 2,000,000 or 1 inch to 31·5 stat. miles. Paris: A. Challamel, 1909. *Presented by the Publisher.*

A new edition of a most useful map, including south-west China, eastern Burma, the whole of Siam, Tonkin, Annam, Cambodia, and Cochin China. It is generally known as the Pavie Mission Map, and was first published in 1895. A new edition, corrected up to 1902 by Commandant Friquegnon, appeared in that year, and now Commandant Tixier, a member of the Franco-Siamese boundary delimitation commission, has revised the map, making use of the latest surveys of this commission, those of the Service Géographique de l'Indo-Chine, and other sources of information. It is clearly printed in colours.

AFRICA.

Egypt. **Schweinfurth.**

Karte der westlichen Umgebung von Luksor und Karnak (Theben) mit Benutzung vom Wilkinson's Topographical Survey of Thebes, 1830, in 1 : 4500 und der Katasteraufnahme von 1904, in 1 : 2500 gezeichnet von G. Schweinfurth. Scale 1 : 25,000 or 2·5 inches to 1 stat. mile. Berlin: Dietrich Reimer (Ernst Vohsen), 1909. *Price* 5 *marks.*

Egypt. **Survey Department, Cairo.**

Topographical map of Egypt. Scale 1 : 10,000 or 6·3 inches to 1 stat. mile. Sheets: N.E. 7–3, 10–2, 10–3, 11–3, 12–3, 12–4, Qaliubia and Menufia Provinces. Cairo: Survey Department, 1909. *Presented by the Director-General, Survey Department, Cairo.*

Morocco. **Service Géographique de l'Armée, Paris.**

Carte du Maroc. Scale 1 : 100,000 or 1 inch to 1·6 stat. mile. Sheets: 1, Bou Beker; 2, Casablanca. Paris: Service Géographique de l'Armée, [1909]. *Price 1 fr. each sheet.*

AMERICA.

Canada. **Department of the Interior, Ottawa.**

Sectional map of Canada. Scale 1 : 190,080 or 1 inch to 3 stat. miles. Sheet 165, Rosebud, revised to May 10, 1909. Ottawa: Department of the Interior, Topographical Surveys Branch, 1909. *Presented by the Department of the Interior, Ottawa.*

AUSTRALASIA.

Western Australia. **Department of Lands and Surveys, Perth.**

Map of Western Australia. Scale 1 : 1,584,000 or 1 inch to 25 stat. miles. 4 sheets. Perth: Department of Lands and Surveys, 1909.

GENERAL.

Oceans. **Johnston.**

Bathy-Orographical Wall Maps: the Atlantic Ocean; the Indian Ocean; the Pacific Ocean. Equatorial scale 1 : 20,000,000 or 1 inch to 315·6 stat. miles. Edinburgh: W. & A. K. Johnston, Ltd., 1909. *Price 12s. each map, mounted on rollers and varnished. Presented by the Publishers.*

These school wall maps of the oceans and adjacent land masses help to supply a felt want, and the fact that they are on an equal area projection (one square inch representing about 100,000 square miles) is a decided advantage so far as comparisons are concerned; although it must be admitted that the consequent distortion of the land forms in the outlying parts of the maps is to be regretted from an educational point of view. Heights of land and depths of water are shown by the usual system of colour-tinting. The maps, circular in form, are all on one scale and of one size, the diameter of the circle being 41 inches.

World. **Bartholomew.**

Cassell's Atlas containing a complete series of Maps of the World, and a full Index of Geographical Names. By J. G. Bartholomew, LL.D., F.R.S.E., F.R.G.S., etc. London: Cassell & Co., Ltd., 1909. *Price 12s. 6d. net. Presented by the Publishers.*

A handy-sized general atlas containing eighty-eight maps of all parts of the world, accompanied by an index to place-names. On the map of Central Africa, No. 56, the thirtieth meridian is still shown as passing through Lake Edward, although recent triangulation has proved that this is not the case, and the western boundary of Uganda is coloured as following down this meridian. The land named by Ross South Victoria Land, in the Antarctic Regions, is called, for some unexplained reason, Queen Victoria Land, both on maps 2 and 6. However, after all these are details, and on the whole this is a useful little atlas for general purposes. The maps are clearly printed, and not too heavily coloured.

World. **Schrader.**

L'Année Cartographique. Supplément Annuel a toutes les publications de Géographie et de Cartographie dressé et rédigé sous la direction de F. Schrader. Dix-neuvième année. Paris: Hachette & Cie., 1909. *Presented by the Publisher.*

The nineteenth issue of this useful annual publication, giving on three sheets of maps, with text on the back of each, a summary of the principal geographical events for the year 1908. On the Asia sheet the journeys and surveys of Dr. Sven Hedin in Tibet, Dr. Stein in Chinese Turkestan, Commandant d'Ollone and other members of his mission in Western China, Captains Butler and Aylmer in Arabia, and those of M. Cl. Madrolle in Haïnan are dealt with. The Africa sheet gives a small map of Mauritania, after the map of Captain Gerard; the new frontier between French Congo and Cameroon; a sketch-map of the Central Sahara, after M. R. Chudeau; a map of Aïr, taken from that of Lieut. Jean; and the frontier between Ethiopia and British East Africa. The third sheet includes America and the Polar Regions. On this is

given a map of Alaska showing the results of the latest United States Surveys; a sketch-map indicating positions determined in Venezuela by the scientific commission; the results of the Mylius-Erichsen Expedition in Greenland; and a map of the Antarctic Regions, showing the results of Shackleton's Expedition. In the space allotted it has only been possible to refer in the briefest manner to the important geographical events, but for general reference this publication will be found useful.

CHARTS.

Admiralty Charts. **Hydrographic Department, Admiralty.**

Charts and Plans published by the Hydrographic Department, Admiralty, during September, 1909. *Presented by the Hydrographer, Admiralty.*

New Charts—No. 2140, Plans in the Natuna islands: Pulo Laut, La Place strait, Telok Selahang to Telok Ranai, Panjang strait, Sedanau channels, Royalist haven, 3*s*. 195, China, east coast, river Min: Mamoi to Fu Chau Fu, 2*s*. 2015, Plans in New Britain (*Neu Pommern*) and New Ireland (*Neu Mecklenberg*): Cape St. George to Sperber point, Watassellibuka bay to Wunatalisse bay, Talili bay, Henry Reid bay, Pondo harbour, Tawanatangir harbour (*Powell haven*), Hixon bay, 3*s*.—**New Plans and Plans added.** 2159, Scotland, west coast, Firth of Clyde and Loch Fyne. New Plan: Troon harbour, 4*s*. 479, Leeward islands, anchorages in Puerto Rico island. New Plan: Port Arecibo, 1*s*. 6*d*. 2204, Plans of anchorages on the north coast of New Guinea, Plan added: Victoria bay, 1*s*.

Atlantic, North. **U.S. Hydrographic Office.**

Pilot chart of the North Atlantic ocean, October, 1909. Washington: U.S. Hydrographic Office, 1909. *Presented by the U.S. Hydrographic Office.*

Atlantic, North. **U.S. Weather Bureau.**

Meteorological chart of the North Atlantic Ocean, December, 1909. Washington: Department of Agriculture, U.S. Weather Bureau, 1909. *Presented by the U.S. Weather Bureau.*

Atlantic, North, and Mediterranean. **Meteorological Office.**

Monthly meteorological charts of the North Atlantic and Mediterranean, November, 1909. London: Meteorological Office, 1909. *Price 6d. each. Presented by the Meteorological Office.*

Atlantic, South. **U.S. Weather Bureau.**

Meteorological chart of the South Atlantic ocean, season, December, 1909, January, February, 1910. Washington: Department of Agriculture, U.S. Weather Bureau, 1909. *Presented by the U.S. Weather Bureau.*

Indian Ocean and Red Sea. **Meteorological Office.**

Monthly meteorological charts of the Indian Ocean north of 15° S. lat. and Red Sea, November, 1909. London: Meteorological Office, 1909. *Price 6d. each Presented by the Meteorological Office.*

Pacific, North. **U.S. Hydrographic Office.**

Pilot chart of the North Pacific Ocean, November, 1909. Washington: U.S. Hydrographic Office, 1909. *Presented by the U.S. Hydrographic Office.*

Pacific, North. **U.S. Weather Bureau.**

Meteorological chart of the North Pacific Ocean, December, 1909. Washington: Department of Agriculture, U.S. Weather Bureau, 1909. *Presented by the U.S. Weather Bureau.*

Pacific, South. **U.S. Weather Bureau.**

Meteorological chart of the South Pacific ocean, season December, 1909, January, February, 1910. Washington: Department of Agriculture, U.S. Weather Bureau, 1909. *Presented by the U.S. Weather Bureau.*

PHOTOGRAPHS.

Assam and Tibet. **Williamson.**

Fourteen photographs of the Lohit-Brahmaputra between Assam and South-Eastern Tibet, taken by Noël Williamson, Esq., in 1907 and 1908. *Presented by Noël Williamson, Esq.*

The expedition during which these photographs were taken was described in the *Geographical Journal* for October last. They are of special interest inasmuch as the upper section of the Lohit Brahmaputra was, before the visit of Mr. Williamson, entirely unexplored.

(1) First view of upper Lohit; (2 and 3) Cane-rope bridge across Lohit; (4) Halli

river; (5) Mijus and Tibetan trader at Sati; (6) Bamboo bridge across Tidding river; (7) The Lohit after it makes its great turn from south to west; (8 and 13) Taroañ; (9) Boulders, Lohit river; (10) Lohit below Sati; (11) Rapids on Lohit below Chang-gu; (12) Bamboo bridge over Du river; (14) Pool where Lohit was crossed above Sati.

Iceland. **Stackhouse.**

Nine photographs of Iceland by J. Foster Stackhouse, Esq. *Presented by J. Foster Stackhouse, Esq.*

A welcome addition to the numerous photographs previously presented to the Society's collection by Mr. Foster Stackhouse.

(1) Isafjordr, general view of town; (2) Isafjordr, from the head of the fjord; (3) Isafjordr, north side of town; (4) Isafjordr, north-west of main part of town; (5) Isafjordr, fish on the drying stones; (6) Patrixfjordr; (7) Stein Grimms fjord; (8) Altar-piece, Holar church; (9) Geyser.

Japan. **Garsia and Reddie.**

Twenty-four photographs of the Japanese Alps, taken in 1909 by Captain W. C. Garsia and Lieut. R. A. Reddie, 16th Lancers. *Presented by Lieut. R. A. Reddie.*

An interesting little set of photographs taken on a trip made during the past summer.

(1) Panorama of the Japanese Alps from Tatayama; (2) Shrine on summit of Tatayama; (3) Tarn 1000 feet below summit of Tatayama; (4 and 5) Snow on slopes of Tatayama; (6) Murodo hut, 1000 feet below the summit of Tatayama; (7) Looking north from halfway up Tatayama; (8) Looking south from halfway up Tatayama; (9) View of Tatayama from valley east of Kurobe; (10) Looking west towards Toyama from Tatayama; (11) Summit of Zaragoe pass; (12) Hut on Kurobegawa river; (13) Japanese Alps looking north-west from Omachi; (14) A primitive bridge on the way to Omachi; (15 and 16) Descending snow-slope on east side of Harinoki Toge (pass); (17) Harinoki Toge (pass); (18) Summit of Harinoki Toge; (19) View from just west summit of Harinoki Toge; (20) Line of ascent up bed of stream; (21) A difficult place; (22) Fording the Kurobegawa; (23) Portion of the path built up with tree-trunks; (24) Carriers on built-up path; (25) Carriers and woodcutters, midday halt.

Portuguese East Africa. **Stevenson-Hamilton.**

Thirty-seven photographs taken during a journey from Ibo to Lake Nyasa by Major J. Stevenson-Hamilton, 1908. *Presented by Major J. Stevenson-Hamilton.*

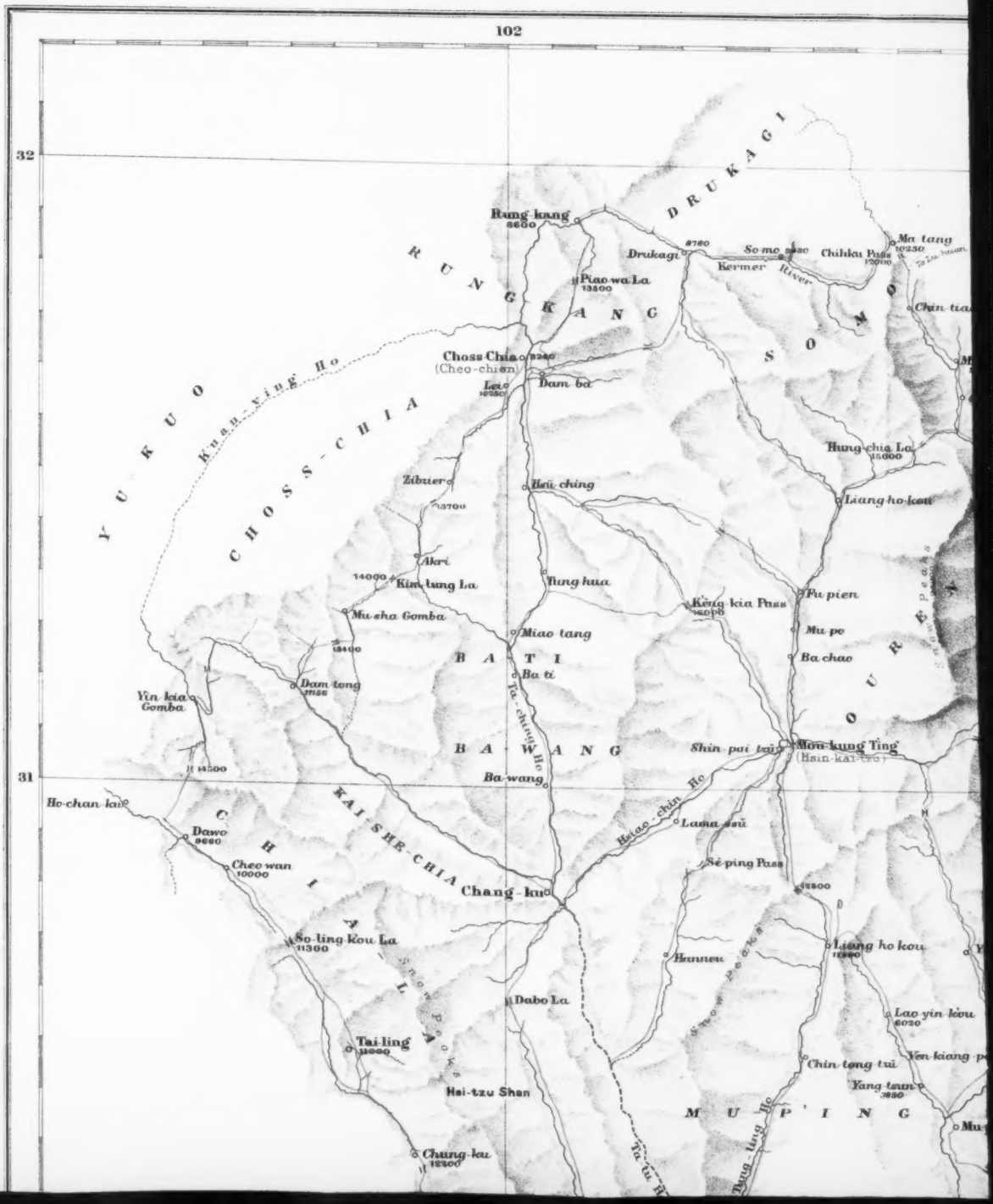
The route traversed through Portuguese East Africa, during which these photographs were taken, was to a great extent new, and in other parts unvisited since the journey of Mr. J. L. Last in 1885–7. Major Stevenson-Hamilton's expedition was described in the *Geographical Journal* for last month. The titles are as follows:—

(1) The church, Ibo; (2) The post office, Ibo; (3) Bamboo brake near Mtepwesi; (4) Mango tree; (5) Makua girl (Medo); (6) Makua boy (Medo); (7) Group of Makua, Mwagidi river; (8) Group of Makua, Umwalia; (9) Fort at Umwalia; (10) Fort at Mavala; (11) Crossing Msalu river; (12) Dugout on Msalu river; (13) Group of Wayao, Msalu; (14) Makua carriers; (15) Chenangololi peak; (16) Cherundu peak; (17) Chemariro hill; (18) Maize in August, Lureko river; (19) Yao chief's grave, Lureko river; (20) Lujenda river opposite Fort Dom Luiz Filippe; (21) Dugout on Lujenda river at Mtarika; (22) Yao village on Lujenda; (23) Yao dancer; (24) Yao and Makua dancers; (25) Yao women, Lujenda river; (26) Yao girl at Mtengula; (27) Yaoman, Lujenda river; (28) Yao woman; (29) Wayside graves, Lujenda river; (30) Katuri's village and Msalala mountains; (31) Fort at Mluluka, Luambala river; (32) Oil palm at 4000 feet; (33) Double-stemmed palm, Nakoba; (34) Long grass at Msalala; (35) Msalala mountains; (36) Kopje near Msalala; (37) Mchembuli hills at Luambala-Lujenda confluence.

Venezuela and Colombia.

The photographs presented to the Society of which a list was given on p. 480 of the October number of the *Journal* were presented, not by Dr. Hamilton Rice, but by Prof. Hiram Bingham.

N.B.—It would greatly add to the value of the collection of Photographs which has been established in the Map Room, if all the Fellows of the Society who have taken photographs during their travels, would forward copies of them to the Map Curator, by whom they will be acknowledged. Should the donor have purchased the photographs, it will be useful for reference if the name of the photographer and his address are given.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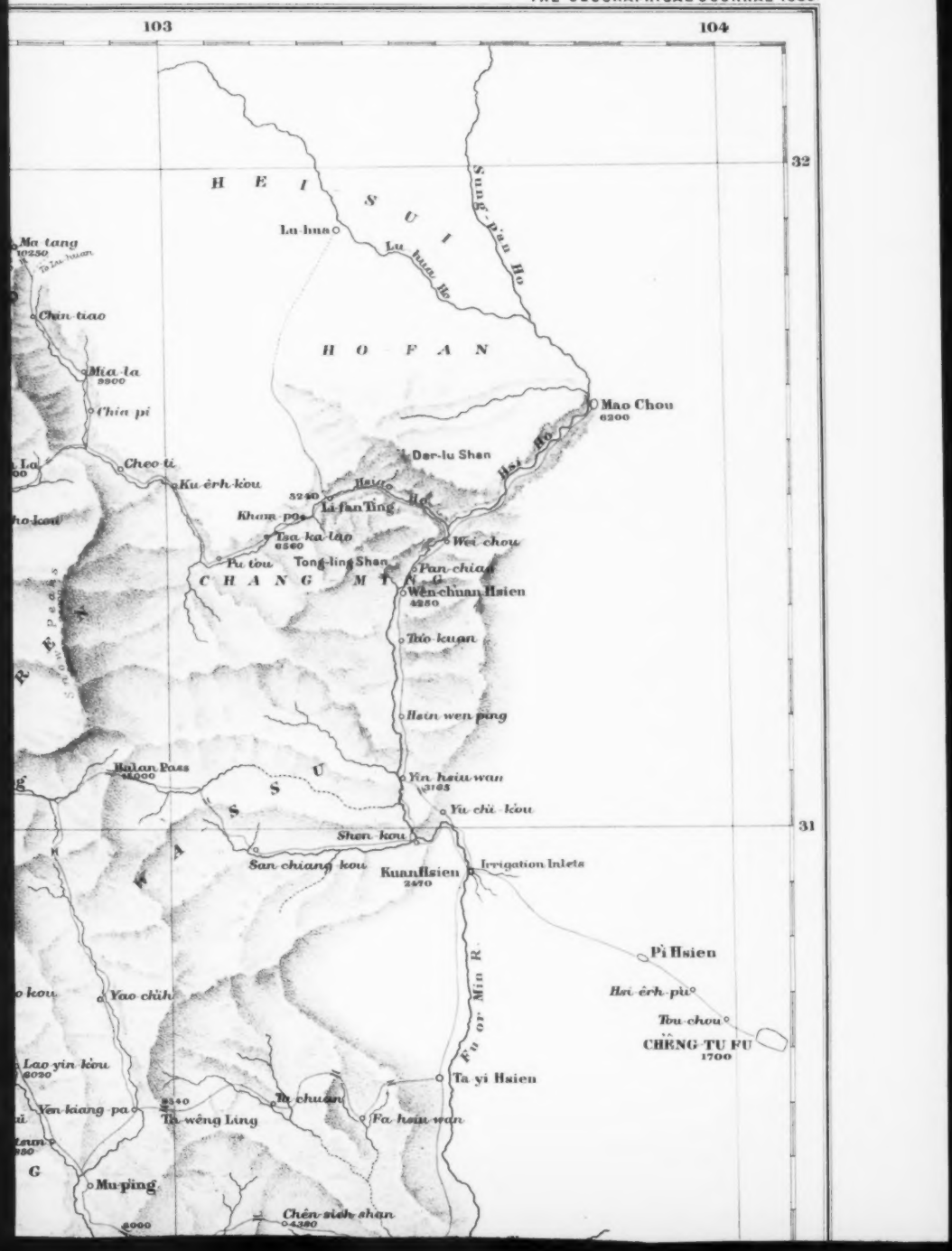
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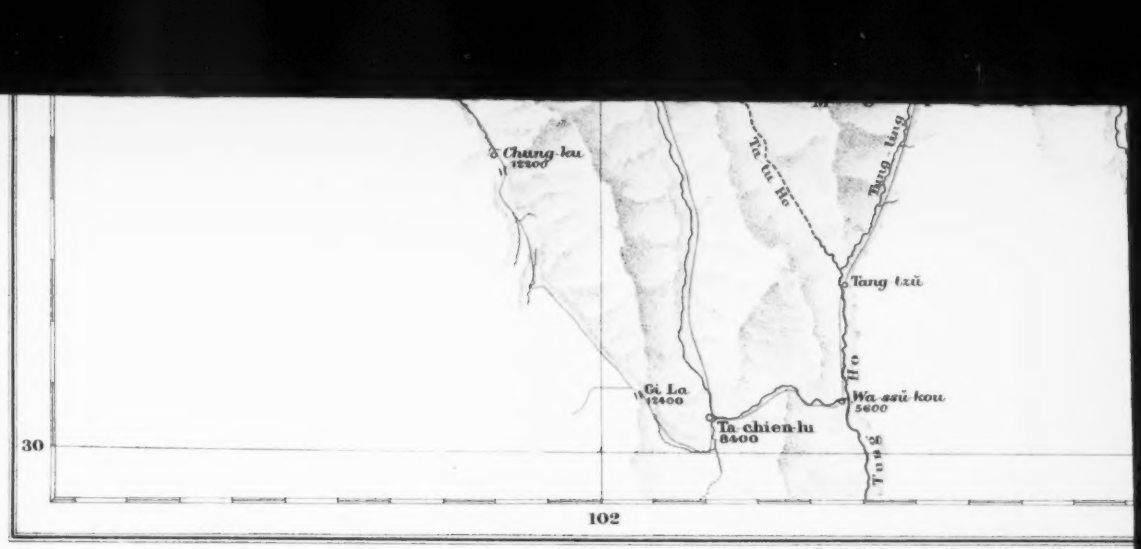

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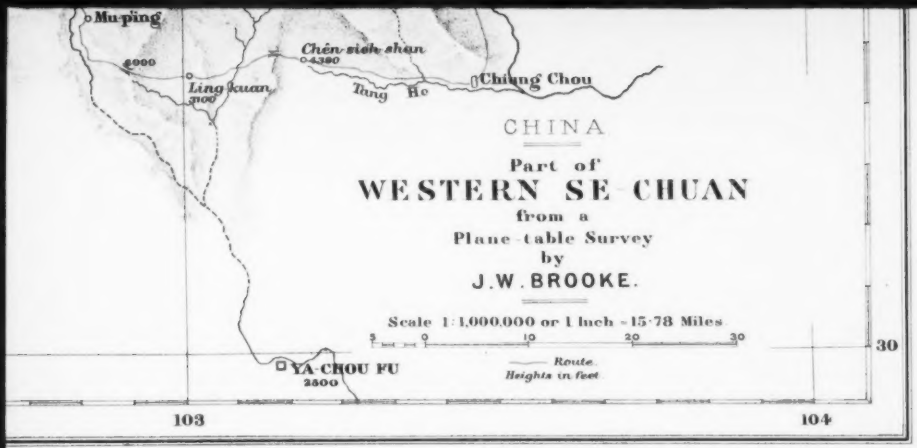

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